ß. 14.

Report and Proceedings

OF THE

BELFAST

NATURAL HISTORY & PHILOSOPHICAL SOCIETY

FOR THE

SESSION 1886-87.

BELFAST:
PRINTED BY ALEXR. MAYNE & BOYD, 2 CORPORATION STREET.
(PRINTERS TO THE QUEEN'S COLLEGE.)

1887.

Referred to in
letter from Mr. J.
Brown (Hon. Treas.)
dated 10 March 88
as having been sent
by the Curator.

13.iii.88.

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Belfast Natural History and Philosophical Society.

ESTABLISHED 1821.

SHAREHOLDERS.

1 Share in the Society costs £7.
2 Shares ,, ,, cost £14.
3 Shares ,, ,, cost £21.

The Proprietor of 1 Share pays 10s. per annum; the proprietor of 2 Shares pays 5s. per annum; the proprietor of three or more Shares stands exempt from further payment.

Shareholders only are eligible for election on the Council of Management.

MEMBERS.

There are two classes, Ordinary Members, who are expected to read Papers, and Visiting Members, who, by joining under the latter title, are understood to intimate that they do not wish to read Papers. The Session for Lectures extends from November in one year till May in the succeeding one. Members, Ordinary or Visiting, pay £1 1s. per annum, due first November in each year.

Each Shareholder and Member has the right of personal attendance at all meetings of the Society, and of admitting a friend thereto; also of access to the Museum for himself and family, with the privilege of granting admission orders for inspecting the collections to any friend not residing in Belfast.

Any further information can be obtained by application to the Secretary. It is requested that all accounts due by the Society be sent to the Treasurer.

The Museum, College Square North, is open daily from 12 till 4 o'clock. Admission for Strangers, 6d. each. The Curator is in constant attendance, and will take charge of any Donation kindly left for the Museum or Library.

BELFAST

Natural History and Philosophical Society.

ANNUAL REPORT, 1886

THE Annual Meeting of the Shareholders in this Society was held on June 17th, 1887, in the Museum, College Square North. Mr. W. H. Patterson, *President*, occupied the chair. There were also present:—Messrs. R. M. Young, R. L. Patterson, J.P.; James Henderson, J. J. Murphy, R. Young, John Greenhill, E. F. Patterson, Joseph Wright, William Gray, William Swanston, James Meharg, Thomas Workman, James Thompson, J.P.; and James Wilson.

Mr. R. M. YOUNG, *Hon. Secretary*, read the notice convening the meeting. He also read the Annual Report of the Council, which stated:—

"The Council of the Belfast Natural History and Philosophical Society appointed by the Shareholders at their Annual Meeting on June 3rd, 1886, desire to submit their Report of the working of the Society during the past year.

"The Winter Session was opened on November 2nd, 1886, with an address from your President, Mr. W. H. Patterson, M.R.I A., the subject selected being "Some Later Views respecting the Irish Round Towers." The second meeting was held on December 7th, 1886, when Mr. Thomas Workman, J.P., read a paper on "Eastern Reminiscences: China and Manilla." The lecture was illustrated by a fine series of photographic and lantern views. The third meeting was held on January 4th, 1887, when Mr. A. B. Wilson gave a paper on "Power." The Rev. Canon Grainger, D.D., M.R.I.A., read a short paper entitled "A Question on the Antrim Gravels," illustrated by a

collection of Irish and other antiquities. The fourth meeting was held on February 1st, 1887, when Mr. Seaton F. Milligan read a valuable paper on "Recent Archæological Explorations in the County Sligo," illustrated by a series of lime-light views, maps, and antiquities. The fifth meeting was held on March 1st, 1887, when Mr. William Gray read a paper on "Technical Education, and our Methods of Promoting it." The sixth meeting was held on March 9th, 1887, when Mr. W. H. Hartland, R.E.C.E., gave a paper on "Sewage Disposal and River Pollutions; its present and future aspect from a sanitary and economical point of view," illustrated by practical experiments upon the treatment of sewage. The seventh meeting was held on April 5th, 1887, when Mr. R. Lloyd Patterson, J.P., F.L.S., read a paper entitled "Some Account of the Whale and Seal Fisheries, past and present;" and Mr. Conway Scott, B.E., another on "Epidemic Diseases: Can they be stamped out?"

"In addition to these ordinary meetings, your Council made arrangements to continue the special series of Popular Scientific Lectures, similar to those given in former years. These have been very well attended, both by the Members of the Society (who were admitted free) and by the general public. They have also proved successful pecuniarily. This satisfactory result must be attributed to the kindness of the lecturers, who so generously placed their services at the disposal of your Council. The first of these special meetings was held on December 10th, 1886, in the Young Men's Christian Association Hall, Wellington Place, when Mr. Henry Seebohm, F.L.S., London, gave a lecture on his "Adventures in Siberia." At the special request of the Council, Mr. Seebohm kindly consented to give a second lecture, subject "The Migration of Birds," in the same hall on December 13th, 1886. The third meeting was held on February 2nd, 1887, in the Ulster Minor Hall, when Mr. W. J. Finlayson, of Johnstone, Renfrewshire, gave a lecture on "Photography," illustrated by a large number of fine photographic views taken by himself. The fourth meeting was held on February 23rd, 1887, in the Ulster Minor Hall, when the Rev. W. S.

Green, M.A., delivered a lecture on "A Dredging Cruise in the Atlantic," illustrated by a large number of original lantern slides. The concluding meeting of the series was held on March 17th, 1887, in the Ulster Minor Hall, when Professor E. A. Letts, Ph.D., gave a lecture on "Fermentation and Kindred Phenomena," fully illustrated. Mr. James Meneely, Belfast, kindly lent his powerful lantern and his services for both Mr. Finlayson's and the Rev. Mr. Green's lectures.

"The financial condition of the Society, as may be seen from the Treasurer's report, continues to show steady improvement. Your Council have let the room known as the Library to the Ulster Medical Society for one year, from 1st November, 1886, reserving due access to the books for the Society's members at all times. The number of smaller societies holding their meetings in the Museum show no signs of decrease. The considerable balance now carried forward will, no doubt, enable the Council of next year to carry out the various much-needed improvements so often deferred for want of funds.

"A list of donations to the Museum, and of publications from the various leading Philosophical and Scientific Societies throughout the world, is printed with the present Report. The Council desire to thank the various donors for their valuable gifts, and particularly Captain Robert Campbell, of the ship "Slieve Donard," who has again supplemented his previous generous donations by presenting a number of rare East Indian fishes and butterflies.

"Your Council arranged this year to have the Museum opened on Easter Saturday and Tuesday, in addition to Easter Monday, at a nominal charge. Some friends, including the Ulster Amateur Photographic Society, Messrs. J. Browne, J. M. M'Gee, and T. F. Shillington, lent valuable exhibits, which had the effect of increasing very considerably the number of visitors and the receipts.

"The ceilings of some of the rooms have been thoroughly repaired. A new book-case has been added to the library. The Librarian has had the books carefully catalogued for some time, and your Council would suggest the advisability of having the

catalogue printed, so as to bring the books more under the notice of the scientific public. A more pressing requirement, however, is the question of printing the catalogue of Irish antiquities, which would add very much to the interest of the fine collection in the possession of your Society."

The CHAIRMAN, in the absence of Mr. Brown, Hon. Treasurer, read the financial statement, which showed a balance in favour of the Society of £62 9s. 2d.

Mr. HENDERSON said he had great pleasure in moving the adoption of the Report read by their Secretary, and also of the Treasurer's statement of accounts. He was very much gratified at the Report, and he thought they had reason to congratulate themselves individually, and Mr. Young, their Secretary, in particular, on the very large number of lectures that were delivered during the past year, on their varied character, and their general excellence. He must ask the members to receive his apology for not coming far oftener to those lectures; but really when one has two or three meetings to attend in a week, to come to a fourth is a little too much, and he found it utterly impossible to attend more than once a month. He had been present at two of the lectures during the year, and there were some present who could support him when he said that they were well delivered and most interesting; while the subjects discussed were calculated to benefit all who were of an inquiring turn of mind. Mr. Young, their Secretary, was kind enough to invite him (Mr. Henderson) to deliver a lecture on his trip to America; but he asked Mr. Young to excuse him from doing so, as he hoped to go back and visit that wonderful part of the country towards San Francisco. He thought the two together would make a better lecture than merely half the journey. The Treasurer's statement was exceedingly satisfactory. It quite surprised him to find an institution of that kind having a balance of £62 odd. He trusted that those much-needed improvements, which it was not necessary to enumerate, would be successfully carried out, and that at next year's meeting they would be able to congratulate the members on the improved appearance of the

building. He had much pleasure in moving the adoption of the Reports.

Mr. William Gray, in seconding the motion, said he could heartily endorse what had been said with reference to the value of the papers brought before the Society itself, as well as the special lectures. Indeed, the Society deserved the thanks of the public for having enabled them to hear special lecturers of great ability. The ordinary papers were interesting to the members of the Association, but the special lectures were of great value to the general public. Those delivered during the year were exceedingly interesting. It was rather unfortunate that they were obliged to change the place in which those lectures were delivered, but he hoped it would not be long until they would have an appropriate room provided by the town. They had been very successful in providing a place for kindred societies, such as the Naturalists' Field Club, who had been long entertained in that establishment, as well as the Photographic Society and the Medical Society. He believed they were carrying out the views of the original promoters in giving every facility to kindred societies to carry on their operations.

Mr. Robert Lloyd Patterson stated that he very cordially and warmly agreed with what had fallen from Mr. Gray with regard to the advantage derived by the Society, and the instruction given to the public by means of the series of scientific lectures which had been delivered during the year. The fact of the lectures being public gave persons not connected with that Society an opportunity of hearing some of the best-known men on different departments of science. He returned his sincere thanks to Mr. Seebohm, of London, who had delivered two lectures in Belfast; and he wished to take that opportunity of saying that he saw Mr. Seebohm in London last week, and told him that they looked with great pleasure on his recent visit to this town. Mr. Seebohm said it was his intention to pay a visit to Africa, and get more information about his favourite subject—the migration of birds. He (Mr. Patterson) requested Mr. Seebohm to pay Belfast another visit, and although he did not say definitely that he would accede to

the request, he did not say that he would not come. Mr. Seebohm told him that he looked back with feelings of pleasure on his late visit to Belfast, and said he was sure he would experience the same pleasure if he came amongst them again.

The Report and statement of accounts were adopted.

PRESENTATION OF A PORTRAIT.

At the conclusion of the Annual Meeting the members met in the lower room for the purpose of receiving from Mr. Richard Hooke a portrait which he had painted of the late Mr. James Macadam, a former President of the Society.

Mr. Joseph John Murphy, who presided, explained the purpose for which they were met. The late Mr. James Macadam was one of the founders of that Society, and he was a gentleman to whom that Museum owed much. At the fiftieth anniversary of the Society Mr. R. L. Patterson gave an interesting account of its history, and among the names of the seven original members was that of Mr. James Macadam, whose portrait had been painted by Mr. Hooke, who was now about to present it. The late Mr. Macadam continued a member up to his death, in 1861. He was one of the best of our geologists, and had a great knowledge of local geology. He contributed many valuable specimens to that Museum. The Chairman then called upon the artist to present the portrait.

Mr. Richard Hooke, who was well received, said when he first thought of presenting that small gift to the Society he had not the slightest expectation that he should be prominent in the matter. He was anxious to secure for the portrait a favourable position in the light, which was very willingly granted. However, when their courteous and energetic Secretary intimated that there was a desire that he should personally present the portrait, he felt very happy at being able to come and meet some of the distinguished members of that Society. It was not necessary that he should say more than that he felt very happy at having it in his power to make the presentation of a portrait of one of their most eminent men. He had been employed a quarter of a century ago by the present Mr. Robert

Macadam to paint some portraits of his family, and a small photograph of the subject of the painting was given to him to enlarge. He made that a specimen portrait, which was a necessary thing for all artists to have. It was hung at the Manchester Exhibitions, and he dare say had he sent it to London it would have been given a place in the Academy. The style was rather out of fashion, and that made it suitable for a museum. The date of the painting was 1863, and it was now as fresh and bright as it was when painted.

Mr. W. H. Patterson stated that, as the late President, he had the pleasure of accepting the portrait on behalf of the Society, and of thanking Mr. Hooke most warmly for having presented it. Not only had the picture expression, but it gave an idea of the late Mr. Macadam's size, which portraits very often did not do. He moved that the best thanks of the Society be awarded to Mr. Hooke for his kindness in presenting the Society with that fine portrait of their former President, Mr. James Macadam.

Mr. Robert Young seconded the resolution, and said he had great pleasure in doing so. He had been very intimate with the late Mr. James Macadam from the time when he was at the Belfast Academy. He was a very distinguished geologist, and one who had taken great interest in that Society. The portrait was a most admirable one, and he thought Mr. Hooke was entitled to their warmest thanks He hoped that was only the beginning of a series of portraits that they should have. They ought to have portraits of their past Presidents.

Dr. S. Browne said he had much pleasure in accepting the invitation to be present. He was a very intimate friend of the late Mr. James Macadam, and he could say that the portrait was a very true one. He had just had the pleasure of seeing a portrait of Sir David Taylor, painted by Mr. Hooke, and it was a most admirable likeness. He (Dr. Browne) was glad to be present, and to have the opportunity of seeing that portrait of one who had been an intimate and valued friend.

Mr. R. L. Patterson remarked that he had known Mr. Macadam from his (Mr. Patterson's) earliest boyhood, and

although twenty-six years had elapsed since he was removed from amongst them, he had a distinct recollection of his former face, of which that portrait was a most admirable representation. He thought Mr. Hooke had made a good beginning by presenting to the Society that picture, and it was their sincere wish that they should shortly see the portraits of former Presidents of the Society adorning the walls of that Museum.

The resolution was unanimously passed, and

The meeting concluded.

Dr. *The Belfast Natural History and Philosophical Society, in account with Treasurer, for Year ending 1st May, 1887.* **Cr.**

EXPENDITURE.

	£	s.	d.
To Cash paid Insurance Premiums	£9	11	3
,, ,, Printing Report	7	9	0
,, ,, Advertising	11	16	5
,, ,, Printing and Stationery ...	7	5	5
,, ,, Water Rate	2	4	7
,, ,, Repairs to Ceilings, etc. ...	21	12	4
,, ,, Postage and other Stamps ...	4	2	6
,, ,, New Book Case	4	0	0
,, ,, Collector's Commission ...	6	11	2
,, ,, Expenses at Easter	11	0	6
,, ,, Wm. Darragh, Salary till 1st May	48	0	0
,, ,, S. A. Stewart, Salary till 1st May, less four months' leave ...	33	6	8
,, ,, Rent till 1st May	25	0	0
,, ,, Fuel and Gas	13	9	4
,, ,, Small Accounts	4	6	10
To Balance	62	9	2
	£272	5	2

RECEIPTS.

	£	s.	d.
By Balance in hand	£33	4	0
,, Interest on Loan to York Street Spinning Company	19	6	9
,, Contribution from Ulster Medical Soc., 1885-6	6	0	0
,, ,, ,, 1886-7	29	4	0
,, ,, Engineers' Assoc.—Arrears	4	3	0
,, ,, Naturalists' Field Club ...	5	5	0
,, ,, Bee-Keepers' Association	1	11	6
,, ,, Ulster Amateur Photographic Society	3	13	6
,, Proceeds of Popular Lectures	10	8	6
,, Donations	8	0	0
,, Transfer Fees	0	15	6
,, Subscriptions	91	2	0
,, Do. in arrear	7	0	0
,, Entrance Fees at Door till 30th April ...	16	14	9
,, Do. do. at Easter ...	35	16	8
	£272	5	2
By Balance	62	9	2

Examined and found correct,
June 2, 1887.

Wm. H. Patterson,
Samuel Andrews, } *Auditors.*

J. Brown, *Hon. Treasurer.*

DONATIONS TO THE MUSEUM, 1886-87.

From Mr. Charles Bulla.

A number of fossil fish remains from the Carboniferous rocks of Armagh.

From Capt. Robert Campbell, Master of the Ship "Slieve Donard."

One case of Indian insects (*Lepidoptera* and *Coleoptera*), one cuttle-fish (*Loligo*), one head of sword-fish (*Istiophorus indicus*), two globe fish (*Tetravdon*), one porcupine fish (*Diodon*), three sea-horses (*Hippocampus*), one cow-fish (*Ostracion*), one hornet fish.

From Mr. William Darragh.

One stuffed specimen of the velvet scoter (*Oidemia fusca*), shot in Belfast Bay.

From Mr. J. T. Erskine, Jordanstown.

One skin of python, from Brazil.

From Rev. Canon Grainger, D.D., M.R.I.A.

A collection of fossils, chiefly from the Carboniferous rocks of Kildare.

From Professor Haddon, F.L.S., Dublin.

Several rare sea-urchins, and star-fish dredged off the southwest coast of Ireland.

From Dr. H. W. Luther.

One large flying fish.

From. J. G. Robertson, Esq., Kilkenny.

Cast of a bronze hatchet, and cast of a portion of the mouldings of St. Canice, Kilkenny.

From Mr. S. A. Stewart.

Two stone implements found on the sandhills at Ballykinler, Co. Down.

From Thomas Workman, Esq., J.P.

Eight bottles of land and marine animals, preserved in spirits.

From Messrs. Fitzpatrick.

Plated disc with engraved crest.

LIST OF BOOKS RECEIVED DURING THE YEAR.

ADELAIDE.—Transactions, Proceedings, and Report of the Royal Society of South Australia. Vol 8, 1886. *The Society.*

BELFAST.—Proceedings of Belfast Naturalists' Field Club. Series 2, vol. 2, no. 6, 1886 *The Club.*

Belfast Society for Promoting Knowledge. Early Belfast Printed Books, List no. 1 *The Society.*

BERLIN.—Verhandlungen der Gesellschaft fur Erdkunde. Vol. 13, nos. 5—10, 1886 ; and vol. 14, no. 1, 1887. *The Society.*

BOSTON.—Proceedings of Boston Society of Natural History. Vol. 23, part 2, 1886. *The Society.*

BREMEN.—Abhandlungen vom Naturwissenschaftlichen Vereine. Vol. 9, part 4, 1887. *The Society.*

BRESLAU.—Zeitschrift fur Entomologie. New series, part 11, 1886. *The Society.*

BRIGHTON.—Annual Report of the Brighton and Sussex Natural History Society, 1885-6. *The Society.*

BROOKVILLE.—Bulletin of the Brookville (Indiana) Society of Natural History, no. 2, 1886. *The Society.*

BRUSSELLS—Annales de la Société Royale Malacologique de Belgique. Vol. 20, 1885.

Bulletin de la Société Royale de Botanique de Belgique. Vol. 25, parts 1 and 2, 1886. *The Society.*

Comptes Rendu de la Société Entomologique de Belgique. Series 3, nos. 72-81. *The Society*

BUENOS AYRES.—Boletin de la Academia Nacional de Ciencias. Vol 8, part 4, 1885. *The Academy.*

CALCUTTA.—Memoirs of the Geological Survey of India (Palæontologia Indica). Series 10, vol 4, parts 1 and 2, series 12, vol. 4, part 2 ; series 13, nos. 1 and 6 ; series 14, vol. 1, fasc. 6, 1886.

Records, vol. 19, part 4, 1886 ; vol. 20, part 1, 1887. Catalogue, 3 parts, 1885 and 1886. *The Survey.*

CAMBRIDGE, U.S.A.—Bulletin of the Museum of Comparative Zoology. Vol. 12, nos. 5 and 6; vol, 13, nos. 1 and 3. Annual Report of the Curator, 1885-6. *The Museum.*

CARDIFF.—Report and Transactions of the Cardiff Naturalists' Society. Vol. 17, 1885.
Flora of Cardiff, 1886. *The Society.*

CASSELL.—Bericht des Vereines fur Naturkunde zu Cassell, parts 31—33, 1884-6.
Festschrift des Vereines fur Naturkunde. *The Society.*

CHRISTIANA.—Forhandlinger i Videnskabs Selskabet, 1886. *The Society.*

DANTZIC.—Schriften der Naturforshendon Gesellschaft, new series. Vol. 6, part 4, 1887. *The Society.*

DAVENPORT, U.S.A.—Proceedings of the Davenport (Iowa) Academy of Natural Sciences. Vol. 4, 1882-4. *The Academy.*

EDINBURGH.—Transactions and Proceedings of the Botanical Society of Edinburgh. Vol. 16, part 3, 1886. *The Society.*

Proceedings of the Royal Physical Society, Session 1885-1886. *The Society.*

Astronomical Observations of the Royal Observatory, being Vol. 15, for 1878 to 1886 (Star Catalogue, Discussion, an Ephemeris). *The Observatory.*

ESSEX.—Transactions of the Essex Field Club. Vol. 4, part 2, 1886, and Essex Naturalist, Nos. 1—4, 1887. *The Club.*

FLORENCE.—Bulletino della Societa Entomologica Italiana. Trimestri 1—4, 1886, and 1—2, 1887. *The Society.*

FRANKFORT.—Naturwissenschaftlichen Vereines des Reg. Bez. Vol. 4, No. 12, 1886–7. *The Society.*

GENOA.—Giornale della Societa di Letture e Conversazioni Scientifiche di Genoa, anno 9, 1 semestre, fasc. 3—5, 2 semestre, fasc. 7, 8, 9, 11, 12, 1886-7. *The Society.*

GIESSEN.—Oberhessischen Gesellschaft fur Natur-and Heilkunde, 1886. *The Society.*

GLASGOW. — Proceedings of the Philosophical Society of Glasgow, Vol. 17, 1885-6. *The Society.*

HAMBURG.—Abhandlungen aus dem Gebiete der Naturwissenschaftlichen herausgegeben vom Naturwissenschaftlichen Verein, Vol. 9, parts 1 and 2, 1886. *The Society.*

KIEW.—Memoirs of the Naturalists' Society. Vol. 8, part 2. *The Society.*

LAUSANNE.—Bulletin de la Societe Vaudoise des Sciences Naturelles. Ser. 3, vol. 22, No. 24, 1886. *The Society.*

LEIPSIC.—Mitheilungen des Vereins fur Erkkunde zu Leipzig, 1884 and 1885. *The Society.*

Sitzungsberichte der Naturforschendon Gesellschaft, 12th year, 1886. *The Society.*

LIVERPOOL.—Proceedings of the Literary and Philosophical Society. Vol. 39, 1885, and vol. 40, 1886. *The Society.*

LONDON.—Cooke's Illustrations of British Fungi. Nos. 42-48. *Lord Clermont.*

Theory of Voltaic Action. J. Brown (Proc. Roy. Soc.). *The Author.*

Journal of the Royal Microscopical Society. Series 2, vol. 6, parts 3—6, and 6a, 1886. Parts 1 and 2, 1887. *The Society.*

Walford's Antiquarian. Vol. 2, no. 63, 1887. *The Publishers.*

Proceedings of the Zoological Society. Parts 1-4, 1886. *The Society.*

Journal of Hydrotherapeutics. Vol. 1, no. 1, 1887. *The Publishers.*

MANCHESTER.—Transactions of the Manchester Geological Society. Vol. 18, part 20, and vol. 19, parts 1-7, 1886-7. *The Society.*

MOSCOW.—Bulletin de la Société Imperiale des Naturalistes. No. 4, 1886 ; and no. 1, 1887, also
Meteorologische Beobachtungen, 1886. *The Society.*

NEW YORK.—Annals of the New York Academy of Sciences. Vol. 3, nos. 9—12, 1885, and
Transactions of the New York Academy of Sciences. Vol. 5, nos. 2—8, 1885-6. *The Academy.*
Bulletin of the American Geographical Society. No. 6, 1882 ; no. 7, 1883 ; no. 5, 1884 ; nos. 3—5, 1885 ; nos. 1—3, 1886. *The Society.*

ODESSA.—Memoirs of the New Russian Society of Naturalists. Vol. 10, parts 1 and 2, 1885-6. Vol. 2, parts 1 and 2, 1886-7, also
Appendix to vol. 10 of Memoirs. *The Society.*

PADUA.—Atti della Societa Veneto-Trentino di Scienze Naturali. Vol. 10, fasc. 1, 1887 ; and
Bulletino. Vol. 3, no. 4. *The Society.*

PHILADELPHIA.—Proceedings of the Academy of Natural Sciences. Part 3, 1885 ; and parts 1—3, 1886. *The Academy.*

PISA.—Atti della Societa di Scienze Naturali, Processa Verbali. Vol. 5, pp. 80—170, and 203—226. *The Society.*

ROME.—Atti della Reale Accademia dei Lincei. Series 4, vol. 2, fasc. 1 and 2, and 5—14, 1886 ; and vol. 3, fasc. 1—7, 1887. *The Academy.*
Journal of the British and American Archæological Society of Rome. Vol. 1, no. 1, 1886 *The Society.*

SAN FRANCISCO—Bulletin of the California Academy of Sciences, Vol. 1, No. 4, and Vol. 2, No. 5, 1886. *The Academy.*

SONDERHAUSEN.—Irmischia. Nos. 1—8, 1886. *The Society.*

TORONTO.—Proceedings of the Canadian Institute. Ser. 3, Vol. 3, fasc. 4 ; Vol. 4, fasc. 1, 1886, and fasc. 2, 1887. *The Institute.*

TRENTON, N.J.—Journal of the Natural History Society. Vol. 1, no. 1, 1886. *The Society.*

TRIESTE.—Bolletino della Societa Adriactica di Scienze Naturali. Vol. 9, nos. 1 and 2, 1885 and 1886. *The Society.*

VENICE.—Notarisia Commentarium Phycologium, no. 5, 1887. *The Society.*

VIENNA.—Verhandlungen der Kaiserlich Koniglichen Geologischen Reichsanstalt. Nos. 7—18, 1886, and 1—4, 1887. *The Society.*

Verhandlungen der Kaiserlich Koniglichen Zoologisch-botanischen Gessellschaft. Vol. 36, parts 1—6, 1886-7. *The Society.*

WARWICK.—Proceedings of the Warwickshire Naturalists' and Archæologists' Field Club, 1885. *The Club.*

WASHINGTON.—Report of the Department of Agriculture, 1885. *The Department.*

Annual Report of the Smithsonian Institution, parts 1 and 2, 1884. *The Institution.*

Third Annual Report of the Geological Survey of the United States, 1881-2. *The Survey.*

BELFAST
NATURAL HISTORY & PHILOSOPHICAL SOCIETY,
SESSION 1886—87.

2nd November, 1886.

The President, WILLIAM H. PATTERSON, ESQ., M.R.I.A., gave an Address on

SOME LATER VIEWS RESPECTING THE IRISH ROUND TOWERS.

THE PRESIDENT traced briefly the position of the round tower controversy up to the period at which Dr. Petrie published his essay. Dr. Petrie's arguments were then reviewed, as were the subsequent writings on the same subject of Sir William Wilde, Mr. Marcus Keane, and Mr. Henry O'Neill. Having referred to the magnificent volumes of Lord Dunraven dealing with the subject, the President directed attention to the more recent writings of Miss Margaret Stokes. He proceeded—In 1878 Miss Margaret Stokes published her "Early Christian Architecture in Ireland." With this work was incorporated some of the matter which Miss Stokes had already given to the world in the concluding portion of Lord Dunraven's book. Miss Stokes holds that the first round towers were erected in Ireland soon after the first invasions of the Northmen for the protection of the religious communities against these Pagan invaders, and that the erection of these church keeps or castles continued for about three centuries—that is, from a little before the year A.D. 900 to about A.D. 1200. In speaking of the state of architecture in Ireland at the close of the ninth century, Miss Stokes says that, although the use of cement and the hammer was known to Irish builders, the horizontal lintel had not yet been superseded by the arch, and at this point we arrive at a class of

buildings which forms a striking innovation in the hitherto humble character of Irish church architecture—that is, the lofty pillar tower. In the beginning of the present century the existence of 118 of these circular ecclesiastical towers was asserted ; of these seventy-six remain to the present time in a more or less perfect condition. Miss Stokes remarks that a certain development of knowledge and skill in the art of building may be traced in these various examples, and that such changes are analogous to those which took place in the church architecture of Ireland after the eighth century. She then attempts a rough classification of the existing round towers, showing the gradation in masonry and the corresponding changes in the character of the door and window opes. There are four divisions into which the towers are classified. First style—Rough field stones, untouched by hammer or chisel, not rounded, but fitted by their length to the curve of the wall, roughly coursed, wide-jointed, with spalds or small stones fitted into the interstices. Mortar of coarse unsifted sand or gravel. Second style—Stones roughly hammer-dressed ; rounded to the curve of the wall ; decidedly, though somewhat irregularly, coursed. Spalds, but often badly bonded together. Mortar freely used. Third style—Stones laid in horizontal courses, well dressed, and carefully worked to the round and batter ; the whole cemented in strong plain mortar of lime and sand. Fourth style—Strong, rough, but excellent ashlar masonry, rather open-jointed, and therefore closely analogous to the English-Norman masonry of the first half of the twelfth century ; or, in some instances, finest possible examples of well-dressed ashlar. Sandstone in squared courses. Miss Stokes then follows with what she calls a broad classification of the towers according to the average styles of their masonry and apertures. Those which belong to the first style of masonry have doorways of the same material as the rest of the building ; sometimes the stones are roughly dressed ; the door-opes are square-headed, with inclined sides ; about 5ft. 6in. high by 2ft. wide, and 8ft. to 13ft. above the level of the ground. In the second and third styles of masonry there will be found in the

doorways the first idea of an arch, the curve being scooped out of three or five stones; the stones of the doorways are generally of some finer material than the rest of the wall, and sometimes an architrave or moulding is introduced. In the fourth style we find the doorways formed with a regular radiating arch of six or more stones, with architrave, or fine examples of the decorated Irish Romanesque of the twelfth century. Miss Stokes considers that the following conclusions may be drawn from those comparisons:—1. That these towers were built after the Irish became acquainted with the use of cement and the hammer. 2. That the towers were built at or about the period of transition from the entablature style of the early Irish period to the round-arched decorated Irish-Romanesque style. 3. That the largest number of these towers were built before this transition had been established, and while the Irish builders were feeling their way to the arch. 4. That as this transition took place between the time of Cormac O'Killen and Brian Borumha—*i.e.*, between A.D. 900 and 1000—the first groups of towers belong to the first date. The average thickness of the wall at the base of the towers is from 3ft. 6in. to 4ft. The usual diameter at the level of the doorway is from 7ft. to 9ft. internally. The towers taper, and their walls diminish in thickness towards the top. In height the towers vary from about 50ft. to over 100ft. Internally the towers were divided into six or seven storeys. The floors, which were of wood, were supported in one of three different ways. The beams either rested on projecting abutments in the wall, or there were holes for the joists; or, thirdly, corbels or brackets supported the floors. The height of the doorway above ground averages 13ft., but it varies considerably. The doorways always face the entrance of the church to which they belong, unless in those instances where the church is evidently much later than the tower, and it is found that the position of the tower was usually about 20ft. distant from the north-west corner of the church. The name by which these towers are usually distinguished by the writers of the Irish annals is "cloicthech," signifying bell-house or belfry. There are numerous references in the annals

of disasters to these belfries by fire, lightning, and other causes. We also learn that persons took refuge in these towers, and that sometimes the protection of the towers was sought in vain. We can picture to ourselves the attacking party breaking in the narrow door, even though fourteen or fifteen feet from the ground, and introducing fire, which burned up the successive wooden lofts, with the unfortunates who had crowded in for refuge. We also find that the guardians of the church used the tower as the safest place they had for the keeping of their sacred utensils, relics of saints, manuscripts, croziers, and bells. It is evident that the towers have suffered very much from the effects of lightning. The old annalists have told us this, and even in modern times several of the towers have been greatly injured by lightning. This is not surprising. The only wonder is, considering the length of time they have stood stretching towards the clouds, that they have not suffered very much more than they have done. The tall shaft of masonry and pointed roof must offer a very dangerous attraction to the electric current. Probably our moist climate and consequent comparative immunity from severe thunderstorms may have helped to preserve so many of our round towers in a very perfect condition. Dr. Petrie cites a passage from Colonel Montmorency's writings showing his idea as to the impregnable nature of the tall circular tower. We have seen by the extracts from our annals that in some cases the tower was not absolutely impregnable. He writes—"The pillar tower as a defensive hold, taking into account the period that produced it, may fairly pass for one of the completest inventions that can well be imagined. Impregnable every way, and proof against fire, it could never be taken by assault. Although the abbey and its dependencies blazed around, the tower disregarded the fury of the flames. Its extreme height, its isolated position, and diminutive doorway, elevated so many feet above the ground, placed it beyond the reach of a destroyer. The signal once made announcing the approach of a foe by those who kept watch at the top, the alarm spread instantaneously, not only among the inmates of the cloister, but the inhabitants were roused to arms in the

country for many miles around." Sir Walter Scott writes :— "These towers might possibly have been contrived for the temporary retreat of the priests, and the means of protecting the holy things from destruction on the occasion of alarm, which in those uncertain times suddenly happened and as suddenly passed away." And to this Miss Stokes adds :—"Consisting of a series of small chambers, one above the other, at a height above ground, they were fitted for places of storage for the sacred things of the church, places of passive defence for the aged and weak, and could afford temporary shelter for from forty to eighty persons from the attacks of an enemy only armed with bows and arrows, and such weapons as we know were in use at the time in the North-West of Europe." After a very full and careful survey of all the matters connected with this subject, Miss Stokes writes :—"The conclusion drawn from all these data being that such towers, though constructed from time to time over a considerable period, and undergoing corresponding changes in detail, were first built at the close of the ninth century, and that a number seem to have been erected simultaneously ;" and again, in speaking of the first arrivals of Danish invaders in this country—"In the beginning of the ninth century a new state of things was ushered in, and a change took place in the hitherto unmolested condition of the Church. Ireland became the battlefield of the first struggle between Paganism and Christianity in Western Europe, and the result of the effort then made in defence of her faith is marked in the ecclesiastical architecture of the country by the apparently simultaneous erection of a number of lofty towers, rising in strength of 'defence and faithfulness' before the doorways of those churches most likely to be attacked. The first descent of the Northmen upon Ireland was in 795, when a party of them sailed across from Wales and plundered the church on the Island of Lambay, near Dublin. The Welsh annals record that the black pagans first came to the Island of Britain from Denmark, and made great ravages in England. Afterwards they entered Glamorgan, and there killed and burnt much ; but at last the Cymry conquered them, driving

them into the sea. From thence they went to Ireland, and devastated Recheryn and other places. Three years afterwards, according to O'Flaherty's chronology—*i.e.*, in 798—they plundered the Isle of Man and the Hebrides. In 802 they burned Iona, and again in 806 plundered the same island, but not without resistance, for sixty-eight of the monastic society of the island were slain. The following year, 807, they entered for the first time the mainland of the West and South of Ireland, and, having plundered the Island of Inishmurry, off the coast of Sligo, they advanced inland as far as Roscommon. In 812 and 813 we find them in Connaught and Munster, where they suffered more than one defeat from the native chieftains. Finally, in 815, or, according to other accounts, in 830, a Norwegian leader called by the Irish writers Thorgils, which name was Latinised Turgesius, established himself as sovereign of the foreigners, and made Armagh the capital of his kingdom. For the purpose of strengthening his position, he placed detachments of his forces at Limerick, at Lough Ree, on the Shannon; at Dundalk Bay, Carlingford, Lough Neagh, and Dublin. For four years Thorgils was able to maintain himself at Armagh, and during this time, by taking command of his fleet on Lough Ree, he plundered all the great ecclesiastical establishments upon the banks of the Shannon, and, having seized the Abbey of Clonmacnoise, and burnt its oratories, he left his wife as sovereign there. This lady's name was Ota, and, according to the ancient record, she gave her audiences, or answers, from the high altar of the principal church of the monastery. During this time, and afterwards, reinforcements continued to reach the Scandinavians in Ireland from their own country." About 837 a fleet of sixty-five ships landed at Dublin, and a few years later an Irish scribe wrote that there was not a point in Ireland without a fleet, and that the sea seemed to vomit forth floods of invaders. From this time on for about two centuries we hear of continued invasions of the Northmen, and there seems to have been no part of the country into which their marauding bands did not pass. The monasteries, being the receptacles of most of the wealth of the country, were

constantly visited and plundered by them. The two nations of Northmen are represented as hostile to each other, and battles between them took place frequently in Irish waters or on the mainland. But these feuds did not interfere with their main object, which was the persistent plundering of the country, and the carrying away as slaves of thousands of men, women, and children. We find that Armagh was plundered by the Danes in seventeen different years from A.D. 832 to 1016, and it was attacked three times in one month. The church of Maghera was attacked three times in one month. Clonard, the seat of one of the great schools in Ireland, was invaded seven times from 838 to 1020. Before the year 900 the Norsemen had first ravaged the coast and the outlying islands, and then their boats were repeatedly seen on the Boyne, the Liffey, and the Shannon. In the valleys of these rivers distinct groups of these towers and churches are to be seen that had been for the first seventy years of this war attacked and desecrated with such fury. After reviewing some historical records as to the building of certain towers and peculiarities in their construction, Miss Stokes writes:—"Thus we find three distinct periods to which these towers may be assigned—first, from A.D. 890 to 927; secondly, from 973 to 1013; thirdly, from 1178 to 1238; and of these three periods the first two were marked by a cessation of hostilities with the Northmen, while the Irish made energetic efforts to repair the mischief caused by the invasions of the heathen. It is clear that these three divisions are distinctly marked by three steps in the progressive ascent of architecture, from the primitive form of the entablature to that of the decorated Romanesque arch. The churches built by Cormac O'Killen are characterised by the horizontal lintel; the church of King Brian, at Iniscaltra, with its still partially developed Romanesque doorway and chancel arch, while retaining the rude form in its minor apertures, marks a period of transition from the horizontal to the round arched style; and the buildings of Queen Dervorgilla and Turlough O'Connor, with the doorway of Clonfert, show what the latter style became in the lifetime of Donough O'Carroll. If Lusk, Glen-

dalough, Timahoe, and Ardmore are taken as types of this gradation in the towers, we see such signs of progress as lead to the belief that a certain interval of time had intervened between the first and last mentioned of those erections." Miss Stokes concludes one portion of her work in the following words :— "There is, perhaps, no question of early Christian archæology," writes Mr. Fergusson, "involved in such obscurity as that of the introduction and use of towers." The difficulty of clearing away such obscurities has arisen chiefly from the want of monuments remaining on the Continent to show what were the earliest types in Western Europe. The light that Ireland might cast upon the subject has not yet made itself felt, because of the uncertainty that has too long lingered about the history of her towers. Dr. Petrie, by his investigations, brought their date down from a pre-Christian time to a period ranging from the sixth to the thirteenth century, and firmly established their ecclesiastical character. Lord Dunraven traced the type from Ireland, through France to Ravenna, thereby proving it analogous to that of buildings belonging to an historic period elsewhere. But he felt that the area was far too wide over which Dr. Petrie had extended the practice of erecting these structures, and was gradually arriving at the conclusion that such masonry as they exhibit was not to be found in Ireland before the ninth or tenth century, and that her decorated Romanesque churches belong to the eleventh and twelfth. Starting from the standpoint of these two archæologists, we may arrive at conclusions which give to these towers their true place in history. From these noble monuments the historian of Christian art and architecture may learn something of the work of a time the remains of which have been swept away elsewhere, and it may yet be seen, as in the case of her institutions, customs, faith, and forms in art, so in architecture, Ireland points to origins of noble things.

7th December, 1886.

W. H. PATTERSON, ESQ., M.R.I.A., in the Chair.

THOMAS WORKMAN, ESQ., J.P., read a Paper on

EASTERN REMINISCENCES, CHINA AND MANILLA.

Mr. WORKMAN remarked that when last before them his reminiscences were of India and Burmah. He would now proceed still further to the East. He would try to enable them to realise what the world is like almost as far round as the antipodes, and possibly beyond, where Shakspere thought of when he said, "One touch of nature makes the whole world kin," though he was somewhat inclined to add, in the words of a more recent poet, "Where every prospect pleases and only man is vile." In January, 1884, he entered the beautiful Bay of Manilla, and he could well sympathise with the expressions of joy and pride with which his Spanish fellow-travellers greeted "Les Philipines," as they called the Philipine Islands. It is a most lovely sight, and the entrance is exceedingly narrow, though the bay opens into an enormous sheet of water more than fifty miles across. At the entrance of the inner harbour a simple monument has been erected to the memory of the great Spanish navigator Magellan, who was killed in one of these islands in 1521. He (Mr. Workman) was much amused at the masher costume of the young Manillan, who is to be seen gaily going about the streets in the airy costume of a pair of trousers and a very white shirt, the latter garment being worn quite loose, and forming a light overcoat.

The lecturer next proceeded to give a minute description of

pile dwellings, observing that all the native buildings are pile dwellings, or modifications of them, and no doubt were first invented as an expedient for raising houses in the water for protection ; but when the race which for generations had dwelt surrounded by water took to living on dry land, the ancient pattern of architecture was followed with slavish exactness. In these houses what would seem almost an impossibility is nevertheless a fact. The ground floor is an addition to the first story; the verandah serves an important purpose, inasmuch as it is the representative of the platform originally intended for the inhabitants to land on from their canoes. Mr. Mossley, who is a great authority on such matters, points out the remarkable resemblance of many of these pile dwellings to Swiss chalets. In the Swiss chalet the basement, enclosed with stone walls, is usually only a cattle stall. The first story is the dwelling-house, and, as in the pile building, it is constructed of wood. It seems possible that the chalet is the ancient lake-dwelling gone on shore—like the Philipine pile dwelling—and that the substructure of masonry represents the piles which formerly supported the inhabited portion of the house. There are similar balconies in the chalets, representing possibly the platforms. It seems probable that the idea of pile dwellings has in many cases arisen through the escape of natives from enemies by getting into a canoe or raft, and putting off from shore out of harm's way. If the attacked had to stay in such a raft or canoe for some time, they would anchor it in shallow water with one or more poles, and hence might have easily been derived the idea of a platform supported on poles.

The lecturer next graphically described his voyage from Manilla to Hong Kong, which was intensely disagreeable. His first view of Hong Kong greatly surprised him, for somehow or other he expected only a low-lying dirty city, entirely devoid of interest, but in this he was mistaken. The curiously shaped boats in the harbour are of great interest, and mostly manned by the families of their owners. Many of these family boats (sampans) are not over 20 feet in length, and some even shorter, built with a low deck, so as not to have more than three feet head-

room below. He was not aware whether the occupants slept in this low hut, or under a 4-feet long swing immediately in front of the stern. The city of Victoria is situated at the base of a hill rising steeply to a height of over 1,800 feet. It is somewhat like, if one could imagine, the waters of the Belfast Lough rising to the level of the Antrim Road, and the town built between it and the steep rocks of the Cave Hill. When he ascended the hill, which he took an early opportunity of doing, he was almost afraid of setting a stone in motion in case he might bring swift destruction on the houses below. He proceeded to describe the town, elaborately commenting, especially on the Botanic Gardens. The streets of Hong Kong reminded him of the streets of Malta, with its flights of steps and narrow ways, along which no carriage can go, so that locomotion is restricted to walking and driving in jinrickshas, something like an overgrown perambulator, or being carried in a chair slung on poles. Chairs made of cane are slung on very long lance poles, and are very comfortable. In the streets one sees a few Chinese women tottering on their small distorted feet, just like goats' hoofs; but there seem to be two distinct races, for there are many women that do not at all compress their feet. Chinese men of the upper classes have a great dislike to manual labour, and, to show that they are quite above such undignified work, it is considered the proper thing to allow the finger nails to grow to an extraordinary length, so that it is not uncommon to see Chinese gentlemen with nails projecting two or three inches beyond their finger tips. While in Hong Kong he took the opportunity of hearing a sermon in Chinese. The sound is very strange, being quite unlike any other language he had heard. It is a monosyllabic language, and seems greatly to want in expression. It seemed to him to run thus :—"Chuck, lick, sim, sam, sang, he, kang, whang." The lecturer gave several other amusing illustrations of the Chinese language.

On the evening of the 14th January he set out for Canton on board the s.s. "Powhan." The centre of the steamer was occupied by Chinese passengers. From that part the forecastle

and poop were divided off by massive bulkheads, pierced so that the European crew and passengers might at any moment pour in a destructive fire on their Chinese fellow-travellers. The appearance of Canton far exceeded anything in the way of cities he had seen; it was truly astonishing; a scene of prodigious life and activity. At Canton foreigners live on a little island called Shameen, which is separated from the town by a canal, over which there are two or three bridges, strongly protected by gates, which are closed every night. These gates were put up recently, he believed, because the mob came over from Canton and had destroyed many of the European houses. This attack was not, however, altogether unprovoked. He had a letter of introduction to a gentleman, who kindly provided a chair with the two bearers and a guide to take him to see the various sights of the city. Soon they reached the midst of the town, with its million and a half of inhabitants on a very little larger area than the town of Belfast. If one were to imagine Bridge Street reduced to the breadth of a narrow lane, lower the tops of the houses to the level of the shop windows, take out all the windows, leaving the shops open, and in some parts roofed to keep off the sun, and then down the sides of the shops and from overhead hang countless boards emblazoned with golden and red characters telling of the class of goods sold within; sprinkle a good deal of scent over all (not attar of roses), then cram the place with people, and behold Canton. The whole passage was one of knock, jostle, crush, but, being seated on a good chair, he was indifferent. When buying from the Chinese one has to keep his wits about him, as the Chinese are smart at all sorts of swindles. He saw a dog and a nice clean little puppy hung up for sale in a butcher's shop. He saw also a rat hung up for sale. Yet Chinese do not eat dirty things, and they set a good example in the clean and tidy way in which they put out meat and vegetables for sale. A duck hung up for sale in Canton appears not unlike a flatfish, owing to the way it has been prepared for the market. A common article of food is the cuttle-fish. The shops are very numerous. In the furniture shops there are beautifully carved chairs and tables made of

dark wood, which, he believed, came from Singapore. There are shops for the sale of jadestone and other ornaments ; jade is very highly valued by the Chinese, and is a very hard semi-transparent stone, of a dark green colour. While speaking of ornaments, it might be interesting to his audience to state that on 6th May, 1850, the late Mr. Getty, an old and valued member of the Society, read an interesting paper on certain seals found in Ireland, and supposed to be of Chinese manufacture. Mr. Fortune, in his account of the Chinese, says :—"There cannot be the slightest doubt that these seals have lain in bogs and rivers of Ireland for many ages. The peculiar white or cream coloured porcelain of which they are composed has not been made in China for several hundred years. They are very rare in China at the present day." There are also in Canton shops for ivory carving and amber work. The most beautiful sort of work to be seen in the Canton shops is the embroidery. There are numerous coffin shops, for the undertaking business is not done in the retired fashion obtaining in this country. A Chinese coffin is a very ponderous affair, and apparently more ornamental than useful. It is formed of trunks of trees, eighteen inches in diameter, cut in two, and chamfered at the edge, and the flat part slightly hollowed out. Four of these slabs joined at the edges go to form the coffin, and two square pieces of wood fill up the ends. There are numerous eating-houses, some of which supply only the flesh of cats and dogs. One restaurant is known by the name of Whoon-Hang-Kau-Maau-Yunk-Poo, which means the sign of the dog, cat, flesh eating-house. Nearly all burdens are carried on the shoulder suspended at the end of a bamboo pole, and, if possible, the article is divided in two, and a part put on each end. The temples of Canton are not wonderful either for size or beauty. The temple of the 500 genii is well known. A geni means a very wise man. Among these 500 worthies is an effigy of the old Venetian traveller, Marco Polo. Another temple visited was that of the five genii and the five rams. It was from these five rams that the city took its name. The paper concluded with a brief statement of the legend of the five rams

and five genii. Mr. Workman added greatly to the value of his paper by employing, as he proceeded, lantern and photographic illustrations.

The Rev. Canon Grainger made some valuable remarks on the Chinese seals found in Ireland. He said that in 1720 a Dublin tea merchant was reported to have sent out a great number of these seals.

4th January, 1887.

W. H. Patterson, Esq., M.R.I.A., in the Chair.

Alexander B. Wilson, Esq., read a Paper on

POWER.

Mr. Wilson said the subject of his remarks, "Power and its Transmission," was too wide to be dealt with in the limits of such a paper, except in a very brief way. He had intended to deal particularly with the subject of compressed air as a power, but, fearing that the question would perhaps be too strictly technical and uninteresting if treated alone, and having regard also to his own connection with the Birmingham Compressed Air Company, he had concluded to deal with the matter in a more general way, rather than with especial regard to the most interesting advances in engineering which are going on in the Midland metropolis. Mr. Wilson then proceeded to explain the different terms used in connection with power, as "horse-power," "foot tons," &c. James Watt and the engineers of his time adopted the expression "horse-power" as the most convenient term by which to convey to the mill and mine owners the capabilities of their engines. The original value of a "horse-power" was based on the work it was estimated a healthy horse could do in a working day, and it was therefore based on two quantities—work and time. In engineering a horse-power consists in the power to raise 33,000 pounds one foot in one minute, or 19,800,000 pounds one foot in a working day of ten hours. This is far too high an estimate of the work of a horse, for it would mean the capability of raising four tons in one day of ten hours to a height equal to that of Divis.

Mr. Wilson then went on to speak of the power developed

by gunpowder in cannon, which is measured by artillerists in "foot tons." One of the 100-tons guns manufactured by Sir William Armstrong's firm for the Italian Government developed and communicated to a target placed 100 yards away a power equal to 40,000 foot tons. This power, if able to be maintained continuously, would be immense; for the energy developed by one discharge only of this gun would be sufficient to lift, say, either of the Liverpool steamships Caloric and Optic, weighing, with cargo, coal, crew, and passengers, some 1,410 tons, to a height of thirty-one feet in ten seconds. Unfortunately, however, this great source of power is applicable to few except warlike purposes.

The supply and sale of power for manufacturing and industrial purposes is of quite recent development, but has already become a recognised system in many large towns where manufactures or works are carried on. It is cheaper for manufacturers using only a small quantity of power to purchase than to produce it; but there is a point where, from the amount required, it becomes more economical to produce than to purchase. In Belfast, perhaps from the fact that fuel is dearer than in towns in England and Scotland adjacent to collieries, or perhaps from the shrewdness of the mill-owners, more care is exercised in the economical production of steam-power than in any other town of the three kingdoms. Even in London, where fuel is dearer, the cost of the production of power is far more than proportionately greater. Mr. Wilson then showed by means of a blackboard the proportionate cost of steam-power per year power units in London, Birmingham, Glasgow, and Belfast. From this it appeared that in London the cost per horse-power per annum for engines of six hundred horse-power ranges from £4 15s. 6d. to £7 7s., in Birmingham from £3 13s. to £5 11s. 2d., in Glasgow from £2 14s. to £5 8s., and in Belfast from £2 10s. to £4 6s. He pointed out how rapidly the cost proportionately increases with the decrease of the amount produced. For instance, the year power unit—that is to say, the cost of one horse-power for three hundred hours—in small engines of 25 horse-power and under frequently

amounts to £25 in London and £22 in Birmingham, being proportionately reduced in larger engines. The cost of gas power may be taken as £26 in London, and £20 1s. 10d. in Birmingham, £19 10s. in Glasgow, and £24 in Belfast per year power unit.

Referring at length to the production and development of steam-power, Mr. Wilson said that during the last twenty-five years, except in some minor points of construction, the form and performance of boilers has been unaltered, tubular boilers having then taken the place of flue, and steel has since superseded iron as the material employed in their manufacture, and enabled much higher pressure to be carried with safety. Much, moreover, has been accomplished in marine engineering in the development of power, especially by the use of compound engines. It may be mentioned that, while the quantity of fuel to produce a pound of steam at 160 pounds pressure is only 3 per cent. more than that necessary for the production of a pound of steam at 30 pounds pressure, the available power obtainable from steam at 160 pounds is nearly 100 per cent. more than from that at 30 pounds. It is for this reason that high-pressure engines have become so generally used, and though the advantages of such pressures were known long ago, they could not be utilised, owing largely to the want of a proper oil. Steam at 30 pounds pressure has a temperature of 274° Fahrenheit, and at 160 pounds pressure of about 370°. Of the animal and vegetable oils applicable for lubricating purposes, some of them at the lower temperature answer sufficiently what is required, while at the higher they become completely carbonised and turn into gas. It was not, therefore, until some of the products of petroleum were brought into use that this difficulty was overcome. The only rival, and that an insignificant one, able to hold its own at all hitherto with steam as a power for manufacturing and propelling agency is gas. In gas engines the motive power is developed by an explosion of a mixture of gas and air below the piston of a vessel resembling a steam cylinder. Some manufacturers claim to be able to work with 22 cubic feet of gas per horse-power, but this he had

found by experiment was too low, and he thought that about 30 cubic feet would be about the average. This would bring the cost of gas up to £20 per year power unit. Mr. Wilson went on to explain at length the principles, advantages, and disadvantages of the gas-engine. Among its advantages might be placed the absence of a necessity for a boiler, with its dirt, heat, trouble, and danger, and this makes it favoured in many small concerns. As at present constructed, however, the gas-engine can never enter into competition with steam for heavy work.

Speaking next of the distribution of power, Mr. Wilson said it was not until the experiments of the Compressed Air-Power Company were made (with which experiments he had himself been connected) that it was discovered that the cost of production in small concerns in general was so large as it turns out to be, a fact which was greatly due to the full amount produced not being constantly required, as well as to unskilful management, and other causes. When the figures were published which proved this, and the Compressed Air-Power Company offered to supply such manufacturers with power at £15 per year power unit, demand was immediately made for 4,000 horse-power on these terms. Various means have been used for the supply of power in this way. First, steam sent in mains through the streets from a central supply; secondly, compressed air laid on in the same way, the compression being effected at a central station; thirdly, water supplied by pipes from a central pumping station, and used to drive hydraulic machinery. The first plan has found some favour in the United States, and the dividends of the companies thus supplying power have been from 5 to 24 per cent. However, there are so many climatic causes to militate against such a system in these countries that it can never be thoroughly successful. The second, that of compressed air pumped into mains at a pressure of 45 pounds above the atmosphere, and delivered in the same way as gas, has, he believed, the largest future before it of any of the three. For all purposes to which steam is applicable, except that of heating, compressed air is equally available. Yet while unsuitable for heating, it may frequently be utilised for the pro-

duction of cold. It does not suffer, as steam does, from radiation and condensation. The first development to any large extent was in connection with the boring of the Mont Cenis Tunnel. From this it has extended to a variety of uses where power is required, more especially in coal mines, where to a distance of three miles or more from the mouth of the pit power of any other kind would be impossible to transmit. After the investigations to which he had referred had been made, the Birmingham Company obtained an Act of Parliament, with the sanction of the municipal authorities, for the construction of the necessary works to utilise the system for supplying power to Birmingham manufacturers. It was calculated that of the amount of compressed air transmitted from the central station, a maximum percentage of 84 per cent. could be obtained by the consumer. The average price they proposed to charge is fivepence per thousand cubic feet, and this would entail to the consumer a cost of £6 14s. 6d. on the best percentage, and £17 on the minimum percentage per horse-power per annum. The system would not be economical applied to large engines of 100 horse-power and over. There are two very strong recommendations in this system most satisfactory to the consumer :—these are, that the quantity supplied can be measured with the accuracy of a first-class gas meter ;—and that no heat or fire can arise from it. Speaking of power as developed by water under high pressure and available for supply, Mr. Wilson said this arrangement was first carried out at Hull, and has since been worked in other towns, but it is very expensive ;—the use of a hydraulic motor involves a year power unit cost of from £40 to £60. As for electricity, it remains for some future Watt to devise a plan whereby it can be produced and applied as a force with sufficient economy to compete with the other sources of power.

In the foregoing remarks the cost of the year power unit is in all cases taken as including coal, oil, stores, labour, depreciation at 5 per cent., and interest on outlay at 5 per cent In the larger class of engines the two latter items in some cases exceed the whole of the former, while as they reduce in size the proportion of coal cost rises rapidly.

With respect to the use of compressed air, and specially as comparing it with hydraulic supply, for the use of motors :—In the case of air, the ordinary steam engine, with unimportant alterations, is used, so that the system may be applied to already existing engines, whereas with water special machines have to be provided. Again, air is elastic, and for varying loads on the same engine can be used more or less expansively; water, being inelastic, each stroke of a hydraulic motor uses the same quantity whether the load be light or heavy. The pipe friction of water as compared with air is roughly in proportion to their densities: taking the former as supplied at 700 lbs. of pressure per square inch and the latter at 45 lbs., the ratio is as 200 to 1. The energy contained in a cubic foot of water at that pressure is but 15½ times that in a cubic foot of air worked even non-expansively, or say eight times that of air worked to best advantage, while its pipe, port, and valve friction is 200 times as great; and, lastly, in hydraulic high-pressure supply there is no reservoir;—the accumulators used can only hold a few seconds' supply;—whereas in air the whole of the mains laid in the streets form a vast receptacle from which supply may be taken for a considerable time without serious reduction in pressure.

4th January, 1887.

W. H. Patterson, Esq., M.R.I.A., in the Chair.

The Rev. Canon Grainger, D.D., M.R.I.A., read a Paper on

A QUESTION CONCERNING THE ANTRIM GRAVELS.

Rev. Canon Grainger read a paper on "The Antrim Gravels," referring to the absence of the characteristic stratification near the surface of gravel hills, and attributing it to the action of sub-glacial rivers at a late glacial period.

Canon Grainger also exhibited a most interesting collection of Chinese, Indian, and other antiquarian specimens, including a magnificent set of jade axes and other instruments.

1st February, 1887.

W. H. PATTERSON, ESQ., M.R.I.A., in the Chair.

SEATON FORREST MILLIGAN, ESQ., read a Paper on

RECENT ARCHÆOLOGICAL EXPLORATIONS IN COUNTY SLIGO.

MR. MILLIGAN said :—The opening meeting of the present Session of this Society was inaugurated by an address from the President on "Some Later Ideas Concerning the Round Towers," when the theories propounded by various writers on this subject were fully discussed. It has occurred to me since this paper was read, that amongst people not conversant with the subject the notion largely prevails that the round towers are the most ancient stone buildings in Ireland. This idea is not by any means accurate, as we have other remains of circular stone buildings or forts that were hoary with the lapse of centuries before the first round tower had its foundation laid.

I am considerably within the mark when I state that there are structures of this class existing in Ireland for more than 2,000 years. If the Annals of the Four Masters are accurate, we have one in Ulster—the Grimian of Aileach, the building of which was completed 1,700 years before the birth of our Lord. These structures have not been written about so extensively as the round towers, and there is less of mystery as to their erection and use. We have not so many perfect examples of them as the round towers; many are dilapidated, and others have only their foundations left to show where once they stood; but the remains that are left point to a period and a civilisation long departed. I refer to the Cashels, or, as they were commonly known to the ancient Irish, the Cathairs, of which I will have

something further to say, having found five of them, or, more strictly speaking, the remains of five Cashels, not previously described. I will also refer to certain sepulchral structures, such as giants' graves, of which I have found a few examples, and another class of stone structures, scarcely if ever referred to by Irish archæologists, which will be rather a new feature to bring before you. I refer to alignments, or lines of standing stones. All these monuments are situated in the county of Sligo, within a radius of five miles from the town of Sligo. Alignments have been found in great numbers in the Department of the Morbihan, in Brittany, particularly in the vicinity of the village of Carnac, in the same district. They have been a puzzle to archæologists as to their use and the motives which led to their erection. I have a hope that the study of Irish alignments will tend to throw some light on these rude stone monuments of ancient times. I have examined a series of photos of alignments in Brittany, from which I have selected three that resemble those in Sligo, which I will place before you on the screen for comparison. The only structure I will refer to previously described is the great megalithic monument in the Deer-park of Hazlewood, concerning which I shall have some further additional facts to place before you.

"County Sligo possesses many places of great interest and beauty; bold cliffs, romantic dells, as at Glencar and Knocknarea ; well-wooded demesnes, as at Hazlewood ; lakes of rare beauty, which yet differ widely in feature, from the cultivated and picturesque surroundings of Lough Gill to the gloomy, wild tarns of Lough Easkey and Lough Talt. Mountain, sea, lake, and wood combine to render the scenery attractive. It affords a field of study to the botanist, the painter, and the antiquarian. In the mountains are rare ferns and Alpine plants. It possesses the most picturesque and varied landscapes, and abounds in objects of striking interest to the antiquarian. Some of the earliest seats of Christian learning are to be found within its limits, as also several of the earliest known Pagan monuments, contrasting in their hoar antiquity with the remains of castles and fortified houses of the settlement which belongs to the

nearer epochs." Such is a condensed description of the county taken from Col. Wood Martin's recent History of Sligo. I have known the county Sligo for many years: its lakes, rivers, mountains, glens, and its warm-hearted and hospitable people, and I must say that I do not in Ireland or elsewhere know of any other district I would prefer to it for spending an instructive and enjoyable holiday. By whatever road the visitor approaches the county Sligo lovely scenery meets his view; the old coach-road by Manorhamilton is very beautiful, "over the Irish Alps," as a driver of Bianconi's used to designate the picturesque pass of Marah.

The route by Dromore West, Screen, and Ballysadare, with its ancient church and magnificent cascades, is also fine. But the most charming road of all is that of Bundoran, Cliffony, Grange, and Drumcliffe. On our left as we proceed this way, we have a splendid mountain range nearly all the way. Benweeskin, Benbulbin, and Turskmore, are the most prominent heights, ranging from 1,722 to 2,213 feet above the level of the sea. Should we ascend Benbulbin, which is comparatively easy, what an extensive prospect meets our view! To the west is the broad Atlantic, to the north-west the Bay of Donegal, protected on its western side by the magnificent mountain of Slieve Leagh, whose perpendicular cliffs on the seaward side are almost 2,000 feet in height. We can observe in the far distance in Mayo the high cone of Nephin, and further still lying off the Erris coast the stags of Broadhaven. Nearer us, to the south, is the range of the Ox Mountains, also Knocknarea, with its huge cairn, Miscaun Meabh, at the base of which lies Carrowmore, with its ancient monuments of the battle of North Moyturah.

Right under us, towards the east, is Glencar valley, with its waterfalls, lake, and crannoges. Between us and the sea, is the ancient plain of Magherow, which contains many forts and sepulchral structures, also some very extensive souterrains, which I have examined and will refer to at another time. Almost at our feet, to the south, is the village of Drumcliffe, with its round tower, cross, and pillar stone—one of the earliest seats of

Christianity in Ireland, founded by no less a personage than St. Columbcille, in A.D. 585. Drumcliffe was burned by the Danes after they had plundered Innismurray, which was the first spot these sea rovers landed on in the western coast in the year 807, when they had a sail of 50 vessels.

Lying off the coast some four and a half miles is the Island of Innismurray, celebrated up to a recent period for the very fine mountain dew distilled there—which did not much increase the Imperial revenue—but more famous as the residence of St. Molaise in the 6th century; not the St. Molaise of Devenish in Lough Erne, but another celebrated man bearing a similar name, which is to the present day a household word in Innismurray. Here are many monuments of Pagan and early Christian times—pillar-stones of undoubted Pagan origin, afterwards consecrated by the Christian saints with the emblem of their faith—the cross—carved in various styles.

These early saints were wise in their generation. Instead of rudely breaking the people off their stone worship, well worship, and Pagan festivals, they consecrated them all to the service of the new faith. They carved crosses on the pillar-stones; they baptised the converts at the sacred wells; they turned the Pagan feasts into Christian festivals, and thus the change to the new faith was the more easily accomplished.

It was by the route last described—by Bundoran and the coast—that the armies of Ulster used to invade Connaught, sometimes led by an O'Neill, at other times by an O'Donnell. There were battles fought here in very ancient times, which we need not now refer to; suffice it to say, this is classic Irish soil. Its ancient history, if recorded by another Walter Scott, would lend a charm and an interest to it equal to any in Europe.

Though this country has been a favourite resort of antiquarians for more than a century past, there still remain many interesting relics of by-gone ages, the existence of which have never been recorded. Beranger, who visited it in 1779, was one of its first explorers. Afterwards Dr. Petrie in 1837, and Mr. Walker of Rathcarrick, at whose seat the ancient stone chair or seat on which the O'Neills were crowned, is still preserved. How it was removed

from the Linen Hall, Donegall Street, Belfast, to county Sligo is related in the *Dublin Penny Journal.* Mr. Walker, who lived at the early part of the present century, opened many of the ancient sepulchral monuments in county Sligo, without leaving any record of the various finds he made, and afterwards disposed of them to an English nobleman, thus doing an irreparable injury to Irish archæology.

Amongst the more recent explorers are Mr. James Ferguson, author of "Rude Stone Monuments;" Colonel Cooper, of Markree; Colonel Wood Martin, the present indefatigable Editor of the Journal of the Royal Historical and Archæological Association of Ireland; Mr. W. F. Wakeman, and others who have given interesting records of ancient monuments of Pagan and Christian origin. Amongst those are the cromlechs, stone circles, and forts, in the townland of Carrowmore, within three miles from Sligo, and first described by Beranger during his visit in 1779. The visit of Beranger to Innismurray in that year is a most interesting narrative, as recorded in a late number of the Archæological Journal, where the primitive customs of its inhabitants are described. Mr. W. F. Wakeman has copiously illustrated and described the plain and inscribed monuments of Innismurray. There is also the great megalithic structure, or, as it is called, the Irish Stonehenge, situated four and a half miles from Sligo, in the townland of Magheraghanrush, to which I shall again refer. This ancient and unique monument is described in the Journal of the Royal Historical and Archæological Association of Ireland, in a paper read by Mr. Edward T. Hardman before the meeting held in Kilkenny on 16th April, 1879. It is also referred to by Mr. James Ferguson in his book on "Rude Stone Monuments," published in 1872. In January, 1886, I visited the Deerpark, accompanied by two friends from Sligo. We went to it for the purpose of examining this monument, and to more thoroughly explore the Deerpark.

The lecturer proceeded to describe this great structure, of which he had maps and accurate measurements. It is 104 feet in length, and 28 feet in breadth at the widest part. Mr. Fer-

guson and Mr. Hardman described it as having a likeness to a cathedral, with its nave, aisles, etc.—but he formed a different opinion, and proceeded to show its likeness to the rude outline of a giant figure cut in the ground, and the figure outlined with huge standing stones from three to six feet in height. Mr. Hardman in his paper says :—" I will not venture on any theory as to the use of this structure, except so far as to suggest that it was the place of a ceremonial observance of some kind. It is clearly not a sepulchral structure, seeing that the solid rock occurs within a foot or so of its surface." He then proceeds to show, borrowing the idea from James Ferguson, that it resembled in its plan a cathedral. What Mr. Hardman supposed to be the natural rock is an artificial flagging which covers the entire of the structure—of which more hereafter.

Mr. James Ferguson refers to this structure as follows :— " What, then, is this curious edifice ? It can hardly be a tomb, it is so unlike any other tomb which we know of. In plan it looks more like a temple—indeed it is not unlike the arrangement of some Christian churches ; but a church or a temple with walls pervious as these are, and so low that the congregation outside can see all that passes inside, is so anomalous an arrangement that it does not seem admissable. At present it is unique, if some similar example could be discovered, perhaps we might guess its riddle."

Mr. Ferguson made no attempt to solve the riddle, neither did Mr. Hardman. The only mode of discovering the secret was by the spade and pick. Having secured the services of two men, we removed the surface soil, and everywhere we examined underneath it was found covered with flat flagstones, below which were loose stones to a depth of another foot. We there found little cists, at a depth of about two feet or better from the surface, containing bones. These cists we found in various places inside the structure, and in every instance contained bones. These bones were forwarded to Dr. Redfern, who kindly examined them, and reported that the human bones had come from bodies, at least three adults and one young person. The animal bones were split to expose the marrow cavities, and were probably

used at a funeral feast. There were bones of the ox, goat, hare, etc. The lecturer read a letter he had received a few days previously from a man who lives in the neighbourhood of the Giant's Grave. He says :—" About twenty-five years ago the landlord of the place made an excavation in the Giant's Grave at the western end, near to the large headstone, at a depth of about eight feet or more from the surface, he found human remains in a vault or crypt of uncemented stones. Several people have still a recollection of this circumstance, so that it is now placed beyond a doubt this structure was erected as a sepulchral monument." * Nothing in the way of weapons, ornaments, or cinerary urns were found in it.

Mr. Elcock, who is an experienced archæologist, and who carefully examined this structure, arrived at the conclusion that it resembled a human figure. Mr. Elcock's opinion and mine were arrived at quite independently of each other. The structure lies almost due east and west—the head at the western end, and what resembles the limbs of the figure at the eastern end. The entrance to the structure is by a passage about two feet six inches wide in the centre of the structure, or looking at it as a likeness to a human figure, this passage is in the centre of the body, at a point that would correspond to the umbilic. It has three trilithons or open doorways, one between the head and body of the figure, at what would correspond to the mouth, and two at the extremity of the body where the passages that correspond to the limbs commence. This is the only structure in Great Britain where there are trilithons except Stonehenge.

The lecturer next proceeded to describe the ruins of a great cashel situated a little to the south of the Giant's Grave. The internal diameter of this cashel is exactly 100 feet, with encircling wall 13 feet thick, the remains of which still stand to a height of from three to four feet. An immense quantity of loose stones, the remains of the original structure, lie scattered around, and a still larger quantity were removed some years previously, for the purpose of building fences. The entrance to this cashel

*** N.B.—Since this paper was read, Colonel Wood Martin has made further excavations, and found a great quantity of bones.**

is well defined. It is on the southern side ; is three feet nine inches wide on the outer side and is three feet six inches on the inner side. The entrance passage is thirteen feet through the thickness of the wall. On the right side of this passage as you enter there is a recess of about six inches deep. I also observed a hole about two inches in diameter drilled to a depth of twelve inches in a large stone. It occurred to me this hole was used for inserting the hinge for the door, and the recess on same side was intended for the door when open to fall back into and leave the passage clear. In the Grimian of Aileach* there are two recesses, one to right and left as you enter, about midway in the passage. I would conclude from this there were two doors, one on either side, closing in the middle, the joint breadth of the recesses being about equal to the width of the passage. If the doors were of stone this would be obviously a good arrangement.

In this cashel the recess is equal to the width of the entrance, which goes to show it was closed by a door hung on one side. There is an angular shaped souterrain in the middle of this cashel, terminating in a bee-hive shaped structure. One of the sides measures eighteen feet. In all cashels I have examined, where the nature of the ground permitted, these chambers were constructed in the ground. At Aileach, which is erected on the solid rock, there are two chambers constructed within the thickness of the wall, one on each side of the doorway. In no instance have I observed chambers in the wall where the ground could be easily excavated. These souterrains and chambers were no doubt intended as storehouses and receptacles for valuable property, as the entrance to them could be so easily concealed or defended.

The lecturer next described another sepulchral structure situated to the south-east of the cashel in the Deer-park. It is like three ruined cromlechs, with the covering stones fallen off

***Note.*—Since this lecture was given, the lecturer had the pleasure of inspecting the Grimian of Aileach with a friend, accompanied by Dr. Bernard of Derry, to whom Irish archæologists are under a deep debt of gratitude not yet acknowledged, for his great labour in restoring this ancient and historic structure.

and lying against the upright stones. At a further distance of about half a mile up the eastern side of the Deer-park, is the remains of another cashel, 180 feet in internal diameter, the encircling wall of which was eight feet in thickness. Within the outer circle are the remains of three interior forts lying from north to south, whilst in the western side the remains of a souterrain filled with *debris* is quite visible. This cashel possessed this advantage: that if a breach were made in any part of the outer encircling wall the interior forts could be defended, which added greatly to the strength of this ancient fort. The stones from this cashel were removed within the memory of people still living, for the purpose of building fences round the Deer-park.

A very peculiar-shaped stone, which the superstition of the people has protected from being removed, is still lying on the eastern side of this cashel. It is known as a Bullan Stone. It is about three feet high and about two feet square;—on its top a basin-shaped cavity is cut to a depth of four and a half inches, with a diameter of eleven inches. The water which lies in these stones is considered by the people as a certain cure for diseases of the eye. Bullan and other cup-marked stones were worshipped in Ireland in Pagan times, and are still held in peculiar veneration by the people, instances of which were given. Earth-fast rocks and stones with cup and ring markings have been observed in India quite similar to those found in Ireland. In India they are still worshipped, and their symbolic meaning understood, in connection with the worship of Siva, who, under the name of Mahadeo, is worshipped as the generator, the sun, etc., and whose type is the Linga. Benares is the head-quarters of this Lingam worship; in temples devoted to it the richer people erect stone pillars over the graves of the departed, whilst the poorer are satisfied with a section of the ground plan of this in the form of two concentric

Note.—The lecturer since reading this paper examined another cashel in county Sligo, the walls of which stand ten to twelve feet in height. It is built on a rock, there is a chamber in the thickness of the wall, and a recess in the entrance passage, together with an outwork not observed in any other cashel.

circles and a central dot, a symbol that has been carved on the rocks all over Europe. Bhavini, the wife of Mahadeo, is supposed to represent the feminine principle in nature. Some light may be thrown on European rock-markings by noting the symbolic meanings held in India concerning them.

A cave dwelling situated a little to the north of the last cashel, 55 feet in length, was next described. It divides in the centre into two chambers, and is from nine to ten feet high and five feet wide. At the entrance to this cave the remains of an ancient hearth was found, and in the midden adjoining, at a depth of two feet, a quantity of bones, and a small bronze buckle, carved on one side, were found.

A description of the townland of Carns was next given, and a map, enlarged from the six-inch Ordnance Survey, was shown, with the various places of antiquarian interest drawn to scale. First, the two huge cairns, situated in a most commanding position on the high ground overlooking the town of Sligo. Next, the outlines and remains of three cashels were described, varying from 60 to 80 feet in internal diameter, with walls from eight to ten feet in thickness. The wall of one, which is ten feet in thickness, stands to a height of about three to four feet. Two of them have the remains of souterrains or cryptic structures, and one has the remains of two encircling concentric walls, thus showing another type of cashel. The most important feature to archæologists are the alignments extending across the hill and parallel to the cashels. A transverse alignment extends up the hill to the cairn of Ton-na-fhoble, a distance of about three-fourths of a mile. In some parts of this alignment the stones are deeply embedded in the ground, and in some places they disappear, but it can be traced till it reaches the cairn on its southern side, at a point where there appears to be an entrance into it. There are three almost parallel lines of stones stretching across the hill, slightly converging at the western side. The length varies from 500 to 600 yards; they run in a line almost due east and west. The distance between the most southern line and the next one is about 100 yards, and the distance from the central line to the more northern one

is about 130 yards. The centre alignment is formed of the largest stones, and they increase in size towards the western end. Where this line terminates to the west, there are two enormous menhirs, one of which measures 11 feet in height and 42 feet in girth, the other measures 10 feet in height and 30 feet in girth. These two immense stones stand quite closely together, and seem from the cleavage to have been originally one. There is an almost complete circle of large boulders, of which the two whose dimensions I have given form the centre. Six stones form the circumference, separated from each other by a distance of about 30 yards, while their distance from the two central stones varies from 25 to 30 yards; there is one stone wanting to make the circle complete. There is a row of stones extending north and south, dividing this circle almost equally in a line with the two central boulders. Besides the two latter there are ten very large stones standing upright—the distance separating them is from 24 to 35 yards, and the entire distance they extend is about 226 yards, about equal to the distance separating the lines that run east to west. In the latter lines the stones are placed closely together, while in that extending north and south they are separated from each other as already mentioned, and are of much larger size.

Reference was next made to similar alignments found in Brittany, in the department of the Morbihan, of which a few views were shown on the screen and compared with those in Sligo. Antiquarians who have spent a great deal of time and research in examining the lines of Carnac, Menec, and Kerlescan, have not arrived at a definite conclusion as to the use of these monuments in the ceremonies of the ancient inhabitants of Brittany. The general opinion is, they were in some way connected with sepulchral structures, and had a place in the worship of the early Celtic tribes.

Proceeding from where the alignments end on the eastern side down hill towards Lough Gill, we entered a field containing the remains of a small circular fort. In the same field are 18 small cairns, or heaps of loose stones, with other stones placed *in situ* outlining the graves, for they are evidently sepulchral

structures. In the next field, still nearer the lake, there is a great pit 75 feet long and 30 feet wide at the broadest part. It is filled with hundreds of loads of loose stones; from one part of it the stones have been removed to a depth of six feet. On a portion of the northern side are upright stones outlining this place in a similar way to many sepulchral structures I have seen. It occurs to me that our ancient history throws some light on these graves and their date.

The Annals of the Four Masters relate that in the year 535 a great battle was fought between Eoghan Bel, King of Connaught, and the Clanna Nial from Ulster, at a place called Crinder. The Annals state that at this battle, which was fought with great fury, the River Sligeach bore to the sea the blood of men with their flesh. Another ancient manuscript, translated by John O'Donovan, states—"That Eoghan Bel was mortally wounded, and his troops beaten by the Ulstermen; that he lived for three days. He told his people to bury him on the hill at the base of which the Ulstermen flee when pursued by the armies of Connaught; that he was to be buried in a standing posture, with his red javelin in his hand and his face towards Ulster, that he might watch over his countrymen when engaged in battle." It is further related, so long as his body remained in this position the Connaughtmen were victorious; but the Ulstermen coming to know of it, came with a great army and removed the body, and carried it northward across the Sligeach river, and buried him with his face downwards at Aenach Locha Gille—thus destroying the talismanic effect of the former interment. The present river running from Lough Gill to the sea, a distance not exceeding four miles, was anciently called the Sligeach. It is on the southern side of this river, and close to it, that the eighteen graves and the large pit is situated.

The large cairn, or what is known as Carns Hill, is on higher ground, overlooking the lake and river. The battle must have been fought here, as the Annals state the slain were carried to the sea by the river. On the hill above the river the cashels

already referred to are situated—a very strong place for the Connaughtmen to fall back on. The graves and pit can be accounted for as the place where those slain in this battle were interred. The large cairn answers to the description of the place where Eoghan Bel was buried, and the chasm down the northern face of the cairn is explained by the body having been removed from that side, and thus causing a displacement or gap in the structure still quite visible. An explanation is required as to the name of the place where the battle was fought. The Annals say it was a place called Crinder. No name like this is now known in county Sligo. If this place was anciently known as Crinder, or Crune Tyr, probably, it would be very appropriate, as referring to the rounded or globular-shaped country, viz.—*crune*, rounded or globular, and *tyr*, a country. Carns Hill is of this shape.

This townland could only have been known as Carns from the time the cairns were erected, and must have had a previous name, which I conclude was the now lost name referred to—from the fact of the burial of the King and the erection of his cairn, and also the erection of the other cairn known as Ton-na-fhoble, or the cairn of the people—the townland from that period would be referred to and called Carns, and the older name would lapse. The lecturer proceeded to prove that the place the body of Eoghan Bel was re-interred in would correspond to the structure now known as the Giant's Grave in the Deer-park. Ancient stone worship was exhaustively dealt with, and the decrees of the various Councils of the Church against stone worship, well worship, and the worship of trees, was referred to.

The use of stones in the inauguration of chiefs and kings in Ireland, and Edmund Spenser's account of such a ceremony which he witnessed in the South of Ireland, was related. The chief was placed on a large stone reserved for that purpose, usually on a hill; he took an oath to preserve all the ancient customs of the country inviolate; he then received a wand, after which he descended from the stone. The ancient

Kings of Denmark were crowned in a circle of stones; the Kings of Sweden were crowned on a stone, around which was a circle of stones on which the nobles sat; the Saxon Kings were crowned on a stone; and the British Sovereigns are crowned with a stone placed underneath the coronation chair. The Kings of Ireland were crowned on a stone at Tara. The O'Neills were crowned on a stone seat which is now in the Co. Sligo.

A very peculiar custom which throws light on Druidical stone circles was referred to. The bards from Wales assembled in the gardens of the Temple, London, in November last, to hold a meeting called a Gorsedd. Twelve stones were placed on the ground, forming a circle; a large stone was placed in the centre. When the ceremony commenced, the bard, who on this occasion represented the Arch Druid—a venerable man of eighty years—who stood on the central stone, and turning his face to the east commenced the ceremonies of the bards, which custom has been handed down from ancient times. Tradition requires that these Gorsedden, or meetings of the bards, shall be held in the eye of the light and the face of the sun. The large boulder, surrounded by a circle of stones as previously described, may have been used for some such purpose, or in the inauguration of chiefs.

It is said the Kings of Sweden were crowned on a stone within a circle of stones, and for each king thus crowned an upright stone was placed in position as a memorial of the event, so that by counting these upright monumental stones the number of kings crowned there could be known. As already stated, Irish chiefs were inaugurated on a stone, as related by Spenser; that being so, might account for the large boulders within the circle, while the ten stones in line might have been erected as in Sweden, to represent the number there inaugurated.

The lecturer concluded by referring to the burial of Absalom, over whom, when interred, a great heap of stones was placed, like the cairns of the ancient Irish. He also quoted the burial of Hector as an illustration of another mode of sepulture

common in ancient Erin, viz., cremation; and the erection of what was probably a cromlech covered with an earthen mound. After the body was burned on the funeral pyre—

> "The bones they took and laid them in
> A casket bright with gold,
> Wrapt round with fleeces soft and sleek,
> All purple to behold.
>
> Soon scooped a grave and in it entombed
> The casket deep,
> And big stones closely o'er it placed,
> And o'er the stones, still hot with haste,
> Flung up the earthen heap."

1st March, 1887.

WILLIAM H. PATTERSON, ESQ., M.R.I.A., in the Chair.

WILLIAM GRAY, ESQ., M.R.I.A., read a Paper on

TECHNICAL EDUCATION AND OUR METHODS OF PROMOTING IT.

MR. GRAY commenced his lecture by tracing the development of animals, and stated that man is the highest form of animal organisation; that henceforth all improvement must be by man's powers of adapting the phenomena of nature to serve his purposes, and not by adapting himself to his surroundings as the mere animal did. His first effort was, doubtless, the formation of a weapon or tool, and his few rudely-fashioned stone implements were the first step outside of, and beyond the capacity of, any previously existing animal, thereby initiating those processes which culminated in the higher achievements of mechanical skill, demonstrating that necessity is the mother of invention, and foreshadowing the advantages of that competition which is the life of trade. The phenomena of mind, the new factor in the struggle for existence, early attracted the attention of increasing mankind, and gave rise to schools of mental speculation, employed in formulating the laws on which the security of society depends: so that in the earliest ages, and in the infancy of nations, it was found that no progress could be made until an obedience to law and order was first established.

Mr. Gray, having traced the rise and progress of the industrial arts from the East through the Romans to Britain, explained that our insular position was not unfavourable to the

progress of mechanical arts in times of peace, and the successes of our arms by land and sea brought the British into contact with other nationalities, and obtained from them the knowledge of materials and methods unknown to us before. We exchanged with other nations in the markets of the world, and men of thought and skill sought refuge in England from the strife and turmoils that disturbed their native provinces. Edward III. encouraged clothworkers from France to settle in Norfolk and other places, for at that period, as Fuller in his Church History tells us, the people knew "no more what to do with their wool than the sheep that wore it." A most important accession of skilled workmen was obtained in consequence of the persecutions that followed the revocation of the Edict of Nantes in 1685, when a large number of workmen in various trades took refuge in England, and were instrumental in stimulating industries in the various towns then rising into importance. This important accession of the Flemish and French refugees to our slowly-increasing army of skilled mechanics stimulated our industries, and contributed to the development of those remarkable discoveries that subsequently revolutionised the industrial world, and did more for the material welfare of mankind than ages of abstract speculation, religious controversy, and military campaigns. But great discoveries were not the outcome of single minds. Robert Stephenson said of the locomotive, "It has not been invented by any one man, but by a race of mechanical engineers." The same may be said of many other important inventions; for like as the lowly coral polyp toils quietly, laboriously, and unostentatiously in the deep, generation after generation passing away, in the effort to elaborate and combine the scanty materials of which the reef is formed, and the winter's storm waves roll far above heedless of the toilers, but do not check their progress, until at length their combined result rises gracefully to bask in the sunshine and the air, a very refuge in mid-ocean, to become clothed with fruitful palms and the beauty of tropical vegetation :— so also generation after generation of obscure toilers investigate phenomena, and accumulate experiences in the quiet of their

retirement, with apparently no practical results, and heedless of the contest of parties and the struggles of native rage around them, until at length the combined results of the continued achievements of human intellects develop into some great discovery recognised in the sunlight of public favour as another vantage ground from which to press forward the cause of civilisation and progress.

The brilliant and rapid advance of scientific discovery in modern times, and the vast improvement in mechanical appliances, justify the anticipation of accelerated progress in the future. There seems to be no practical limit to the development of industry, or to the application of the products and forces of nature for the purposes of mankind, wholly independent of nationalities. The common result, as well as the special advantages of every accession and every fresh discovery, are rendered available to all by the increased facilities for intercommunication and the removal of those hindrances, social and physical, that heretofore separated nation from nation. But while the universal distribution of knowledge, and all the advantages that follow discovery and the culture of science and art are inevitable, and desirable in the interests of advancing civilisation, they involve from a commercial view, a closer competition and a keener struggle for existence, and remind us that the position we or any people can take in the struggle, will depend upon the skill, experience, and culture we employ to maintain it. In mediaeval times the squire, the clergy, the yoemen and well-to-do citizens were bound by law to train up their descendants to practical industries. The obligations thus imposed were liable to inconvenient abuses, and the practice fell into disuse, and was superseded by the apprenticeship system. Under the apprenticeship system a youth, bound to serve his master for a term of years, had a fair chance of acquiring a knowledge of his trade, for it brought him into direct contact with his master, and was made familiar with all his business. This was especially the case so long as almost every tradesman was himself a master, and not a mere journeyman in the employment of others.

All the operations of industry were then protected and regu-

lated by trade guilds, and a knowledge of the trade was considered a mystery, jealously guarded by the members of the guilds, who were masters of the mystery—craftsmen or handicraftsmen. In modern times the printer's "devil" has outwitted the craftsmen by exposing all their secrets. In rural districts masters were not so much specialists as all-over men. A smith was a blacksmith, locksmith, nailer, farrier, and perhaps horse doctor. A carpenter was also a joiner, wheelwright, cabinetmaker and millwright. Their factories or workshops were their own homes, in which the apprentice often resided, or, at all events, was brought into daily personal contact with his master, and was thereby enabled to acquire a thorough knowledge of his trade. But the development of manufacturing machinery, with the consequent erection of large manufacturing concerns, and the concentration of skilled labour into large towns, destroyed the apprenticeship system; and to-day the youthful apprentice is passed into a factory, like a sheep into a paddock, to do the best he can for himself. He has no immediate responsible master. But as extensive factories and large establishments of all kinds have become an absolute necessity to keep pace with the progress of our manufacturing industries, and as the principle of a division of labour must be acted on to secure excellence and economy, it is quite manifest that the system of apprenticeship, which cannot be dispensed with, must be modified to meet the requirements of modern industrial operation. The apprentice should, in fact, be technically educated, or he cannot acquire in the workshop or factory the skill that is required by the refinement of processes, and the straining after excellence and perfection in every detail of our modern industries. In this sense we must look on technical education as a system, and not as a mere branch of education—a system that directs every stage of the pupil's educational career, so that he may be prepared to efficiently discharge the duties of life and maintain the struggle for existence. Adopting this view of technical education, it is evident that as a method or system of education it can be applied to our most elementary schools, as the foundation of our educational edifice; and as

the stability and permanence of the superstructure depends upon the efficiency of the foundation, it is manifest that anything wanting or imperfect in our elementary education will be proportionately injurious to the educational superstructure raised upon it.

After referring to the defects of the purely voluntary system, Mr. Gray referred to the establishment of our National education system, and said that in consequence of the apathy of the public, denominational jealousies, and other causes, the old parochial idea was retained in formulating the National education scheme, and the control of the schools drifted into the hands of clerical managers, and consequently the system as a system, while it had accomplished much good, has failed to realise all that its founders anticipated with reference to technical education. If we compare our school buildings with the schools of England and Scotland, we will find a marked contrast. The great majority of our National schools are built on waste, good-for-nothing spots. The buildings are dingy, uncared-for, ill-ventilated, and badly lighted. The report of the Education Commissioners shows that over 23 per cent. of our National schools are without any out-offices, yards, or playgrounds. At a meeting of the Teachers' Congress in Dublin Dr. Cameron said :—"In the rural districts the schools were, with a few exceptions, wretched structures, being sometimes mere mud cabins, with cold clay floors and thatched roofs. Taken as a whole the National schools were mean, ill-conditioned buildings, quite unworthy to be used in connection with one of the noblest of man's works—the cultivation of the human understanding." Such is the testimony of a sanitary authority. We speak of the necessity for compulsory education. Would it not be a breach of Martin's act against cruelty to animals to compel children to attend such schools ?

The total absence of suggestive objects, natural and manufactured, is a most radical defect in our national schools, for without them our youths are brought up incapable of appreciating the phenomena of the natural world, or its requirements, and consequently know nothing of the various channels into which

their own labour might hereafter be practically directed; hence when it is time for lads to leave school both they and their parents are too often utterly at a loss to know what the lad is to be put to, or what he is fit for. He has been taught to work hard to get result fees for his teacher, and he is glad to be relieved from this labour. Beyond this he has rarely no other definite idea as to the necessity, value, or object of the education he has received. Without this he is heavily handicapped in his future struggle for existence. Referring to the use of tools in schools, the lecturer said there are many things desirable that are not always practicable. This seems to be the case with reference to teaching the use of tools in schools, where our youths, as a rule, have so short a time to devote to the cultivation of the senses and mental faculties as means for acquiring and properly applying the laws and principles that underlie the practical industries of the country. Other agencies besides tools may be employed for the purpose of developing and directing manipulative skill, or dexterity of hand, such, for example, as drawing and modelling. The lecturer strongly recommended this, as well as the study of natural science, and stated that the defective training in the elementary school is a great hindrance to the effective working of the more practical classes under the Science and Art Department, for a great deal of the students' time is lost in their school making up the elementary deficiencies. This is most marked. The School of Art and the teachers' time, which should be devoted to the more advanced studies, is wasted in endeavouring to get the student to grasp the more elementary lessons in drawing. No wonder that the parents and friends so often complain of the time spent on elementary work, and the slow progress made by the students. Mechanics wanting this elementary instruction attribute their slow progress at schools of art to the teachers' want of practical knowledge rather than to their own want of elementary knowledge. Had the student's eye and hand been properly trained in the elementary school at the time when the eye and hand are most readily trained, he would be prepared to profit by the teaching in the School of Art, and advance to higher stages more rapidly. The lecturer

having referred to the want of prizes or rewards of some kind in connection with our National schools, said the children of Model schools obtain certificates and prizes as the result of annual examinations, and there seems to be no reason why a similar system should not be insisted upon in every ordinary National school as a means to stimulate efforts to excel and to deserve, and in acknowledgment of superior merit. At present our National or elementary schools have no direct connection with the Intermediate or higher schools. There is a missing link in our educative chain which should be supplied by a system of scholarships open to pupils of our National schools, thus connecting the elementary schools with the intermediate and higher schools, and making the way clear for worthy pupils to pass from the lower forms of our provincial schools into the highest places in our educational system. Our Schools of Art and Science established in 1851 constitute effective agencies for promoting technical education. During the ten years that succeeded the Great Exhibition of 1851 the art schools worked quietly and effectively, and their influence on the industrial progress of the country was acknowledged by foreign juries in the Exhibition of 1862, who stated that England had "made amazing progress." Since then, further improvement has been made, and the resources of the central schools and museum at South Kensington have been greatly extended, with correspondingly increased advantages to the provinces. The number of national scholarships taken by any school may be accepted as a very fair indication of the efficiency of the school. In this respect Belfast has done well, and occupies a high position in comparison with many others in the kingdom. During the fourteen years following the establishment of our local School of Art, Belfast has taken the third place among the schools of the kingdom. Within that period the number of scholarships taken by South Kensington was 16, Birmingham 10, Belfast 8, and no other school took more than 6. The science classes at the Working Men's Institute, under Mr. Barklie, have been equally successful, and last year the result fees, independent of prizes, amounted to £600. In common with the manufacturers of the nation

generally, our local manufacturers seem to be unconscious of the importance and value of such agencies as our schools of art and science, and take very little interest in their labours. So recently as the inquiry of the Technical Commission in Belfast, a local manufacturer stated that the School of Art was of little use to manufacturers, although at that very time his manager was negotiating for the employment of one of our pupils as a designer in his works, and has employed school of art pupils since with acknowledged advantage. The technical education of pupils must become more specialised as it advances, and in order to meet the requirements of trade, must be carried much further than the education provided by the State. For this purpose all available external agencies must be brought into operation, among the most ancient and honourable of which stand the wealthy livery companies of London, who, recognising the necessity for promoting technical education, established in 1877 the Guilds of London Institute, for the purpose of promoting technical education among the industrial classes. Their general scheme was formulated on the lines of the Science and Art Department, and developed to a practical issue the annual examinations and technical subjects, which were previously organised by the Society of Arts in 1856. The institute's syllabus contains thirty-five subjects, including all our productive industries, and payments are made to teach and support prizes awarded to pupils upon the results of examination in each subject. We have, therefore, working side by side these two agencies for the promotion of technical education among the working classes—the Crown, by means of the science and art schools, and the Guilds of London Institute, by means of the technological programme, taking up the student where he is left by the State, and teaching him the practical application of his acquired knowledge of science and art.

The lecturer described the very excellent work done by the pupils of the Technical School and the Science and Art Classes, particularly the classes at the Working Men's Institute, showing that in the national competitions the Belfast students have more than held their own in competition with some of the most

important Schools and Colleges of Science in the kingdom. Referring to the difficulty in getting Schools of Science in the country, the lecturer said these difficulties and hindrances must continue until local authorities awake to see the necessity for adopting some more systematic method of applying the educational resources of the country for the purpose of promoting the interests of our national industries. In this direction trade societies could render effective services. Indeed, without their sympathy and hearty co-operation no system of industrial education can be effectively brought home to the artisan, and unless this is done, and effectively done, much of our educational efforts of the day will be little better than a dissipation of energy. Whatever scheme is founded it should be equally available for all industries. "In a general way it may safely be predicted that the nation which has the most varied industries is likely, all other things being equal, to be the most prosperous, powerful and contented." The success of our technical education will depend upon how it is applied in the interest of the young pupils or apprentices in the several branches of trades, rather than in the interest of older hands, who have discovered by experience the disadvantages of neglected education. Assistance in the latter case should not be withheld, but no substantial or permanent improvement can be made unless the career of the young mechanic is carefully guided at every stage, but especially at the apprenticeship stage.

We have already traced the altered relationship between the master mechanic and his pupil in consequence of our factory system, close competition, and division of labour, and it becomes a question of vital importance to ascertain how, under existing circumstances, to remedy the difficulties which our modern apprentices have to contend against in acquiring a practical knowledge of their trades. The concurrent testimony of all practical authorities is that the apprenticeship system cannot be superseded by any other form of education in trade, but that the difficulties which surround him in the whirl and push of our modern factory, render it all the more necessary that his wits should be sharpened, his observing powers cultivated, and

his mind stored with information applicable to his calling, before he enters the factory or workshop. Unfortunately masters as a rule fail to test the pupil's ability and qualifications, unless to serve some immediate and inferior purpose, and the pupil is left to work his way as best he can. This is a radical defect. Considering the number of educational advantages now available, masters would secure the most effective service of their apprentices, stimulate elementary education, and generally promote the improvement of the industrial arts, if they would refuse to admit any youth as an apprentice who had not made sufficient progress in the recognised Schools of Art, Science, and Technology;—certificates of competency being obtainable from all such schools, there could be no difficulty in applying this test. Trade societies having to a great measure assumed the duties of the old trade guilds, are now called upon in their own interest to see that the apprentices to the various trades are registered as properly qualified. Unless some technical certificate is required by trade societies from candidates for membership, the educational status of the artisan cannot be improved. One of the most honourable of the London companies, the Plumbers' Company, had a rule as old as the time of Edward III. to the effect that "No one of the trade of plumbers shall meddle with works touching said trade except by the assent of the best and most skilful men in the said trade testifying that he knows how well and lawfully to do his work, so that the said trade may not be scandalised or the community damaged by folks who do not know their trade."

The teaching of trades is what is rendered possible under the scheme of the Guilds of London Institute, and skilled workmen of any trade having qualified under the Institute can earn result fees by giving instruction in their respective trades. Practically, the adoption of this system is limited to towns where suitable accommodation can be provided in the shape of classrooms, workshops, or demonstration rooms and fittings, as in the case of the Science Schools at the Belfast Working Men's Institute, which received aid from South Kensington towards fitting up the chemical laboratory, and the Technical School,

Hastings Street, which received aid from the London companies. The difficulty in forming trade schools in rural districts has been successfully overcome in the case of the Fishery Institute, at Baltimore, County Cork, where a school has been established for teaching boys "every art connected with fishing, from the making of lines and nets to the building of boats, curing of fish," &c. This has been established under the Industrial Schools Act, which will ensure an annual capitation grant from the State and a smaller sum from the county for each boy under instruction, and for the same purpose Grand Juries, or the Town Councils of Dublin, Limerick, or Cork, can obtain loans from the Crown at three and a half per cent. for altering, enlarging, building, or rebuilding industrial schools. There seems to be no reason why this Industrial Schools Act should not be extended to all properly constituted trade schools. Probably it would be if the zeal manifested in the case of Baltimore Fishery School was more general throughout the country. In Belfast, favoured by the existence of the Queen's College, which is sufficient to meet all the possible demands for high scientific education, what seems most required is a connecting link between the Science and Art Schools and the workshop and factory, so that the pupil or apprentice having entered the latter may be able to obtain that practical instruction by skilled workmen which there is no time to impart in the factory and no proper means of demonstrating in the lecture-room. For this purpose suitable workshops and apparatus will be required for all trades, and the teaching staff may be selected from the qualified teachers under the Guilds of London Institute, as at the school in Hastings Street, or they may be nominated by the respective trade societies interested in the welfare of their trade apprentices.

The Technical Schools of Huddersfield, Bradford, Nottingham, and Leeds, embrace the teaching of science and art as in our Government School and Working Men's Institute, and the teaching of technology as under the Guilds of London Institute, and in many cases aim at a still higher standard by endeavouring to accomplish in arts and medicine what is effectively done

by our Queen's College. We in Belfast may fairly leave the high cultivation of science and original research with the College, and content ourselves by the endeavour to utilise the provisions of the Science and Art Department and the Guilds of London Institute for the benefit of the industrial classes. While acknowledging the superior excellence of both organisations for the accomplishment of their intended purpose, there is a certain amount of incoherence about them that militates against their complete success. The Public Libraries Act was intended to remedy this defect, by placing in the hands of a permanent municipal authority funds for the promotion of popular technical education by the establishment of Libraries, Museums, and Schools of Music, Science and Art, and more effectively to apply such other funds as may be voluntarily placed in their hands for similar purposes. Many of the chief towns of the kingdom have utilised the powers of the Libraries Act with great effect, in exciting public interest in favour of technical education and raising noble buildings as appropriate homes for Literature, Art, and Science.

Belfast will probably have, under the powers of the Act, a municipal building architecturally equal to any, but to make it complete as a means of promoting technical education, it should embrace an economic museum and art gallery, and if external or voluntary aid will admit, it should provide class-room and workshop accommodation for the teaching of science, art, and technology, thus forming one central educational establishment or Victoria Institute, qualified to teach the principles and practice of science and art in their relation to our national industries, as successfully as the Queen's College prepares the students for the University. And if our wealthy merchants of Belfast would only strive to realise such a scheme this Jubilee year, it would go a great way towards stimulating the Government to provide for the Queen's College the additional accommodation for scientific demonstration which it has claimed so long and still so badly requires. Whether this can be accomplished or not, the central institution, even as an auxiliary to the Schools of Science, Art, and Trade cannot be

complete without a good economic and art gallery, in which our mineral and other national products should be exhibited, and their several uses in the arts illustrated, with the processes by which they are rendered available. In our industrial museum we should have selected examples of our home and foreign textile productions, patterns, processes, inventions, improvements, suggestions, and the combinations of industry that are being provided to meet the increasing requirements of advancing civilisation. Mr. Gray closed his lecture by describing the advantages that would arise from such a central institute not only to the Schools of Art, Science, and Technology, but to the public generally, and hoped that a strong effort would be made to have it established as a memorial of the Jubilee year.

At the close of the paper the Chairman invited discussion.

Mr. YOUNG congratulated Mr. Gray on having treated his subject in an able and comprehensive manner, and expressed himself in favour of having a proper School of Technology and a Museum for Belfast. He did not think, however, that the building should be connected with the Library, but considered it would be much better in another part of the town.

Mr. GREENHILL said that, at the suggestion of the Mayor, a committee had been formed for the purpose of carrying out the preliminary arrangements in connection with a Technology School, and adverted to the essayist's remarks in connection with apprentices, observing that he would much prefer the lad who got his training in a small shop, where his duties were of a varied character, to the apprentice in a large establishment, who was kept constantly at one class of work.

Mr. CARSON complimented Mr. Gray on the excellence of his paper, and suggested that it should be published in pamphlet form.

Mr. GRAY, in reply, said he would not like the Town Council to have the whole management of the school, but he would take advantage of the Council's power under the Libraries Act so as to render the School or Institute permanent by being conducted under the Council as the municipal authority.

They had been told that it would be unfortunate for it to be connected with the Town Council, inasmuch as they would be swamped with rates, but the Act providing a penny rate was passed for the purpose of limiting the rate to a penny, though of course he knew there had been efforts to make the rate two-pence. He thought, however, that it would be unfortunate if they were permitted to tax the ratepayers in this way, because it would have the effect of checking voluntary efforts and contributions. With regard to having one building, he certainly would not go in for swamping all the others into one institution. His idea was to have a central building containing the necessary appliances for the other institutions which would gather round the museum, and that the municipal committee should be the directing authority, having their central building equipped with such appliances, apparatus, models, examples and diagrams, as may be necessary to aid and stimulate the efforts of any or all the schools or classes established throughout the town for the promotion of any form of Technical Education.

9th March, 1887.

W H. Patterson, Esq., M.R.I.A., President, in the Chair.

W. H. Hartland, Esq., C.E., read a Paper on

SEWAGE DISPOSAL AND RIVER POLLUTION: ITS PRESENT AND FUTURE ASPECTS, FROM A SANITARY AND ECONOMIC POINT OF VIEW.

The Lecturer began by stating that probably no subject connected with the public welfare demands a closer or more philosophical inquiry than this. One of the first authorities of the day has recently made use of the words, "I am compelled to admit that the subject of sewage generally is in a frightful mess." The dangers to public health are almost infinite in number and character, and the legislative attempts to guard against them promise soon to become not alone a serious burden upon the pocket, but an irksome interference with the freedom of domestic life. Yet the chief dangers from sewage disposal are not, like those from bad food or drink or overcrowding, patent to all, and thus easily avoided. They are underground and out of sight, almost unknown, yet always active and ready to spring up and destroy us, whenever a favouring condition of circumstances may arise. What constitutes a satisfactory system of disposal? His reply would be this—Purify the sewage before putrefaction sets in; all the rest will follow as a matter of course. Providence, indeed, will do the rest in the shape of "aeration," for pure air no sooner meets with either foul odour, liquid, or matter than a struggle commences—it proceeds to purify them. In the right application of these principles it may be we shall find a revolution in the present methods of procedure, both of treatment and of

sewer construction. What is the present aspect of this question? In the last half century there has been literature on it wholesale, parliamentary commissions, blue books, reports without end, yet the upshot of all is found in Dr. Tidy's recent statement that the subject is in "a frightful mess."

The chief end of the Legislature has been to prevent river pollution, in order that rivers and streams may be restored to the public as sources of pure air, clean water, fish life, &c. But the opponents of legislation ask, "What is the use of further legislation, when the present is almost a dead letter from the difficulty and increasing expense of putting it into practice?" Let us examine the procedure that has led to this result. The first point to be noticed is engineering. There was generally some great scheme for the purpose of gathering up and concentrating in one stream the whole nuisance of a locality, and then passing it on to a neighbour. If anything illustrates the adage, "The farther you go the deeper the mire," it is sewage disposal on these terms. The next method of procedure was sewage farming. This was at one time looked upon as the grand solution of the problem. Although large sums of money have been expended in this way it is gradually being abandoned. Next, there is settlement and after filtration. Grave sanitary reasons soon showed the fallacy of filtering raw sewage, and the settling tank was brought into play. But the after filtration over areas of land involves numerous difficulties—a great deal of land is required, it soon gets "sick," and has to rest; yet if the land be of a suitable quality a step is made towards the economic use of sewage by the affinity of the filtering medium for the more volatile and valuable elements in the sewage, and the land has become manured; but the season for manure is limited, whilst that for sewage is constant, and we are compelled to go on "in season and out of season." The "pail system," with its handful of charcoal to arrest and to deodorise the volatile elements has a certain economic value, but is repulsive and can never be popular, and besides it leaves half the drainage of the towns, and that in point of fact the most

objectionable, untouched. The lecturer proceeded—We now come to what is termed the scientific or chemical treatment of sewage. It may be stated briefly that natural laws, applicable to liquid purification, are—First, subsidence ; second, natural oxidation ; third, the general laws of chemical affinity—with the latter is combined filtration. No matter how carried out, chemical treatment aims at accomplishing one or other of the effects natural to these laws. In precipitation or forced subsidence, the agent used is generally lime. In the oxidation of organic matter, permanganic acid, or salts of iron, we often used, either with sulphate of alumina, or with lime. The A B C, or alum, blood, and clay process, has been keenly fought over, and is yet in controversy. The new process at Southampton by which three grains of "very porous carbon" are added to each gallon of sewage, probably effects little more than a partial deodorisation of the liquid. Some other chemicals would seem to operate quite as much by bleaching, as by really purifying the sewage. But the bulk of these systems all aggravate the difficulty of the "sludge" or solid deposit from the sewage by adding, in the form of lime, alumina, or other ingredients, immensely to its bulk, and none of them are carried out except at great cost. The Birmingham Drainage Board, for instance, has £400,000 invested in works (not sewers), and the sewage treatment of London, in the manner proposed by Mr. Dibden, is estimated to cost annually £118,000 ; another system proposed, but not adopted there, contemplated an outlay of 3¼ millions and an annual expenditure of £198,000 ; whilst a third proposal went as far as 3¾ millions, and £219,000 of an annual expenditure. In attempting to describe the possible future aspect of sewage disposal I may be allowed a little latitude, but will avoid as far as possible merely theoretical conclusions. The main question depends on obtaining a system of purification that shall be of universal application. If in so doing we can minimise the cost, and so reduce the ratal burdens, we shall have accomplished something ; if we can obtain a cheap manure, we shall have benefited the largest industry in the country. I am not going to tell you that "Peruvian guano"

can be manufactured from sewage, but simply that an honest attempt can be made to recover that amount of natural value which sewage undoubtedly has. In former systems the more volatile and evanescent of these elements have been allowed to pass away, or have been simply neutralised. I would go farther —retain them. In the apparatus before me there are three, or indeed four, sections, for I propose to perform in detail what other systems do all together, and so fail to accomplish either. In the first section I apply the natural process which is to be seen at the mouth of the Blackstaff—*i.e.*, to allow the solid matter to settle by quiescence to the bottom. In the second section the liquid, freed from the grossest of this, flows between and through filter boxes filled with, let us say, coarse lime or chalk. These operate in a twofold manner—they serve both as a mechanical filter and as a chemical neutraliser for such acids as exist more or less in all sewage. In the third section the liquid, having gone through these preliminary stages of purification, falls to a lower level, one foot, or two or three feet, as the case may be, but falling by means of spray plates in a highly divided form through which a current of air passes. This is aeration, and is the system nature applies in every river or running stream. Then in the fourth section the highly aerated and oxidised liquid passes through a second series of filter boxes containing charred and earthy matter whose natural affinity for ammonia takes up more or less of this valuable constituent of manures. The final stage of this is subsidence, in the last tank, of all the remaining sediment, chiefly the finer organic particles. The fully purified effluent then passes away at any, even if necessary at a dead level—it is clear water, no longer sewage. Each part of the system is in duplicate, each may be of any convenient size, and any number can be placed side by side, so as to be applicable either to one central area, to a series of drainage areas scattered over one large town, or to a separate institution, workhouse, a hospital, or to a private house, or group of houses. The chief difficulty in all sewage questions has been the disposal of the "sludge." In the system I propose the sludge is not the manurial element in which I rely—for that purpose it may be

disregarded—the more valuable elements I have intercepted in another form. Nevertheless, the sludge remains to be disposed of. We will suppose that a commercial attempt is being made to utilise the value of the elements retained as manure; then the same fuel employed to create the aerating draft, to pump when necessary the low-level outfall and to work the filtering materials by grinding, &c., will also dry and calcine the sludge. The oxidised sludge is mixed with the coarse filtering materials by precipitating them into a drying floor or underground flue, which conveys the waste heat; here the material may lie undisturbed till dried. It may also be mixed with the ordinary town refuse, and the whole thus dried together, and once dry it can be treated as an ordinary raw material for manure, or more correctly as a vehicle for the reception of other valuable manure constituents, as in ordinary artificial manure industry. At the close of the lecture Mr. Hartland explained that owing to an accident to his experimental apparatus in transit from Glasgow, it had been necessary to effect some repairs, and they were only accomplished just before the lecture. He hoped, however, that the apparatus would be in full working order next morning, and anyone calling at the Museum after twelve o'clock would find it at work purifying the Belfast sewage.

A discussion, which was chiefly of a technical nature, followed, in which Rev. Robert Workman, Mr. Wm. Gray, Mr. J. J. Murphy, Mr. L. L. Macassey, C.E.; Professor Everett, Mr. E. N. Banks, C.E., and Mr. F. W. Lockwood took part. Mr. Hartland replied, and the meeting concluded.

17th March, 1887.

William H. Patterson, Esq., M.R.I.A., in the Chair.

Professor Letts read a Paper on

FERMENTATION AND KINDRED PHENOMENA.

The subject which I have chosen for this lecture is one I may say of extraordinary interest and importance, not only in a purely scientific sense (though it has opened up several new fields of research), but equally if not more so from a practical point of view, as it deals with a wide range of subjects of much practical importance, and involves questions of the greatest moment to the whole human race. Among the latter there is a great deal that bears directly upon the causes, nature, and prevention of disease, and I feel that I may be charged with presumption for discussing this branch of the subject, which belongs more particularly to medicine and surgery; but my excuse must be that it is also very intimately connected with chemistry—in fact, its medical and chemical aspects are linked by the closest bonds, and I do not see how they can be discussed apart.

Let me first direct your attention to ordinary fermentation—the change which occurs in the manufacture of all spirituous beverages, such as wine, beer, whisky, &c.

Fermentation has been known from the earliest times. The art of wine making was attributed by the Egyptians to Osiris, by the Greeks to Bacchus, whilst as every one knows the Israelitish tradition assigns its discovery to Noah.

I suppose every one is aware how wine is made: that the grapes are crushed and the juice exposed to the air, when after some time a frothing occurs, and spirit gradually makes its

appearance in the juice, whilst in proportion its sweetness becomes lessened. Here we have a case of spontaneous fermentation, and the reason why wine-making is such an ancient process at once becomes apparent: for the first person who pressed out grape juice and allowed it to remain undisturbed for some time must have been the conscious or unconscious discoverer of fermentation.

But in the manufacture of other alcoholic beverages, such as beer, &c., the conditions are not so simple, for something must be added to the "sweet wort," or infusion of malt, to cause the fermentation, and that something is "yeast" or "barm."

Here let me at once say that in all cases of ordinary fermentation two things are necessary (1) a solution of sugar (2) yeast. I will explain presently why yeast is not *added* to grape juice, merely remarking that it is found abundantly in the juice after it has fermented.

I have here some sugar (not ordinary sugar, but the same sugar which exists in grape juice—hence called "grape" sugar) dissolved in water. To the mixture I have added some yeast, and the whole has been kept at about blood heat for some six hours.

You observe that the liquid is frothing, or "working" as it is called, and it is from that phenomenon that the term fermentation is deried [*fervere*—Lat. *to boil*]. Now this frothing is due to the escape of a gas (as was first noticed by Van Helmont) and that gas, as we can readily demonstrate, is carbonic acid.

I have here another experiment proceeding, namely, the distillation of some fermented sugar solution, to show you that spirit has actually been formed.

Now, as we took nothing originally but sugar and yeast, it is obvious that the spirit has been produced from them; and as at the end of the experiment we find the yeast in undiminished quantity, whereas some or the whole of the sugar has disappeared (according to the conditions of the experiment) it is obvious that the spirit and carbonic acid have come from the sugar. In fact it has been ascertained that the sugar is decomposed in

a perfectly definite manner, which we may represent by what is called a chemical equation, thus:—

$$\underset{\text{Grape Sugar.}}{C_6 H_{12} O_6} = \underset{\text{Carbonic Acid.}}{2\,CO_2} + \underset{\text{Spirit or Alcohol.}}{2\,C_2 H_6 O}\ *$$

What has caused this change in the sugar? It must be apparent to you, I think, that it is the yeast (for nothing was present but the two things, and it can easily be proved that sugar will not ferment without the yeast). Then comes the question, and it is the very essence of the whole matter—What is the nature of the influence which the yeast exercises?

Loewenhoeck was the first to examine yeast under the microscope in 1680, and to find that it consists of very minute globules. Cagniard de Latour in the present century took up Loewenhoeck's work, which had almost been forgotten. "He observed that yeast consists of a mass of organic globules susceptible of reproducing themselves by means of buds which appeared to belong to the vegetable kingdom, and not to be simply organic or chemical matter, as supposed. He concluded that it is very probably by some effect of their vegetation that the globules of yeast disengage carbonic acid from the saccharine liquid and convert it into spirit."

The great German chemist Liebig took, however, a totally different view of the matter—a view which he can scarcely be said to have originated, as his ideas were almost identical with those of Willis and Stahl, chemists of the 17th century. His theory was as follows:—Yeast, and in general all animal and vegetable matters in a state of putrefaction, will communicate to other bodies the condition of decomposition in which they are themselves placed. The motion which is given to their own

* The chemist employs a kind of shorthand to represent the composition of substances and their decompositions and reactions. The "equation" in question indicates, first, the composition of the "molecule" or smallest particle of grape sugar capable of existence—the small indices showing how many atoms of the different elements it is composed of are present: "C_6" representing six atoms of carbon, "H_{12}" twelve atoms of hydrogen, "O_6" six atoms of oxygen. It also shows that the molecule of sugar is decomposed into two molecules of carbonic acid (each containing one atom of carbon and two atoms of oxygen) and two molecules of spirit (each containing two atoms of carbon, six of hydrogen, and one of oxygen). The term "equation" is employed because the number of atoms on each side of the = sign is the same.

elements by the disturbance of equilibrium is also communicated to the elements of the bodies which come into contact with them.

Then a third view was advocated by Berzelius and Mitscherlich, viz., that the yeast acts, as the chemist phrases it, "catalytically," that is to say, causes the decomposition of the sugar by its presence while it remains unchanged. This explanation is the more plausible as many such actions are known. For instance, the decomposition of bleaching powder into chloride of calcium and oxygen by peroxide of cobalt.

I do not wish to detain you longer with these historical particulars, nor can I follow out the chain of arguments which eventually led to the correct explanation of fermentation. It must be sufficient for me to state that Pasteur proved conclusively that the fermentation of sugar is inseparably connected with the life of the yeast cell; in fact, that the sugar is the soil or food upon which the yeast lives, and that the carbonic acid and spirit are waste products—just as the carbonic acid which is exhaled from our lungs is a waste product, the carbon being derived from the food we eat.

A few words as to the structure and life history of the yeast cell. When yeast is examined with the microscope under a rather high power it is found to consist of myriads of minute globules, which are round or oval. Careful investigation has shown that these globules or "cells" consist of a mass of protoplasm surrounded by cellulose. They are, in fact, paper bags full of protoplasm. The protoplasm, like the cellulose envelope, is colourless, sometimes homogeneous, sometimes composed of small granulations. In the protoplasm are usually seen one or two dots or "vacuoles," as they are called, which are cavities containing liquid. If the growing yeast cells are carefully watched under the microscope they are seen to alter their appearance with considerable rapidity. Sometimes at one, sometimes at two ends, small bladder-like prominences make their appearance, which gradually enlarge, and at last having attained a considerable size lessen in diameter at their base, and eventually separate themselves from the parent cell and lead an independent existence.

It is by this process of budding that yeast usually multiplies; but there is another method of reproduction which occurs only under special conditions. In this method we find definite seeds or spores produced *in* the cell. Spore formation occurs when yeast is deprived of nourishment and is exposed to a damp atmosphere. "Under these conditions the vegetative life of the yeast ceases suddenly, and in a few hours we see great changes take place in the protoplasm of the cells. The oldest and those which are poorest in protoplasm die and break up. While others grow larger, their lacunœ disappear and the protoplasm is diffused uniformly in the cellular juice. At the expiration of from 6 to 10 hours we notice the appearance in the midst of the protoplasm of from 2 to 4 small islets more brilliant and dense than the rest, around which fine granulations collect. These dense spots do not present any appearance of a nucleus, and they become differentiated more and more until they are exactly spherical; 12 to 24 hours later each becomes invested with a membrane, very thin at first, but which thickens by degrees. The spore is then ripe." These spores or "ascospores" as they are termed, are about $\frac{1}{3}$ the size of the mature yeast cell, and they have a much higher degree of vitality than the cell itself, and an infinitely greater power of resistance to destructive agencies. Thus they may be completely dried, and even exposed to a pretty high temperature, without losing their power of germination. They are, in fact, similar to the seeds of ordinary plants, and like many of these are distributed by the air. I think we may compare yeast with a bulbous plant, say a hyacinth, which at times reproduces itself by subdivision of the bulb, at others by the production of true seeds. Now, the ascospores of yeast are found in ordinary dust; and as grapes and other fruits are exposed for a long time during their growth to the atmosphere, a layer of dust collects on their surface and mixes with the juice when the fruit is crushed. Hence we can easily understand the spontaneous fermentation of grape juice and the juices of other fruits, such as those of apples and pears. Indeed, the spores of yeast have been found on the skin of the grape.

Let us return for a few moments to the process of fer-

mentation, as there are several points which deserve attention. We have seen that the yeast cell has the power of transforming sugar into spirit and carbonic acid. Are these the only changes it produces? Pasteur's elegant researches have shown the contrary. He has proved that other substances are always found in fermented liquids. One of these is glycerine, another succinic acid. Then we have a mixture of other bodies which are separated during the distillation of spirit, and are in chemical properties allied to that substance. The mixture is termed fusel oil.

The yeast cell is composed, as I have explained, of two parts essentially, viz., a bag or lining membrane of cellulose and an interior of protoplasm. During fermentation, yeast is constantly multiplying, so that its weight at the close of the operation is six or seven times greater than it was at the commencement. It is obvious that it must derive its nourishment from the fermenting liquid.

Pasteur showed by the most careful and convincing experiments that the cellulose envelope was derived directly from the sugar. We know, in fact, that a very close relationship exists between the two bodies, and that their mutual transformation is constantly occurring in the vegetable kingdom. But a difficulty arises as regards the protoplasm, for it contains nitrogen, and that element is absent from sugar.

Here again Pasteur has given the correct explanation, and has shown that yeast will not thrive for any length of time in a pure sugar solution, but requires for its nourishment certain salts and nitrogenous substances. These it finds in the juices of fruits or in malt infusion, but if fermentation is to be conducted with a pure sugar solution they must be added, at least if the fermentation is to continue.

Pasteur after various experiments succeeded in producing an artificial medium in which yeast grows luxuriantly. It contains in addition to water and sugar, tartrate of ammonium and yeast ash, or in place of the latter an artificial ash containing the same salts. We may compare with perfect propriety the ammonium tartrate and yeast ash to artificial manures, which are now used so extensively in agriculture.

Another very interesting point in the history of yeast was, I think, also first brought to light by Pasteur, viz.:—that the yeast cells when introduced into a liquid medium containing oxygen absorb that element with great rapidity, and develop a corresponding quantity of carbonic acid. This is a veritable respiration, exactly resembling the respiration of animals. Indeed, it has been proved that this respiratory act of yeast is as energetic, and even more so, than the respiration of fishes, which occurs in exactly the same manner, *i.e.*, by the absorption of dissolved oxygen from water. As fermentation can take place in a proper medium without free oxygen, Pasteur appears to have formed the theory that the fermenting character of the yeast cell is due to the power it possesses of breathing at the expense of the sugar, and that the latter's decomposition into carbonic acid and spirit is the consequence of the act by which the oxygen is removed from the sugar. In this case the latter must suffer a far more complex change than is usually supposed.

From all these considerations we see that yeast is a very simple form of plant life, the spores of which, owing to their minute size and lightness, are widely distributed. We also see that like other plants it requires a definite soil for its growth and nourishment, and also that in growing it gives rise to perfectly definite chemical products which are formed from the nutritive material, viz., sugar.

Does yeast stand by itself in these respects, or are there other ferments similar to it in general functions?

To this question science has given a very decided answer in the affirmative, and has shown beyond doubt that there are almost countless ferments in air, dust, and water, which, while resembling yeast in the nature of their functions, differ from it in several essential particulars. And this leads me to the second division of my subject, viz., the question of *spontaneous generation.*

I may introduce this part of my lecture by some extracts from an address by Professor Huxley given some years ago to the British Association.

"From the earliest times the doctrine prevailed that under

favourable conditions, of which putrefaction was one of the most important, animals could be produced without parents."

The ancients were deeply imbued with this idea, and we find it again and again discussed or spoken of in their writings; whilst in the Bible itself we find passages which evidently refer to it. Lucretius said—"With good reason the earth has gotten the name of mother, since all things are produced out of the earth, and many living creatures even now spring out of it, taking form by the rains and the heat of the sun." The great philosopher Aristotle maintained that every dry substance which becomes moist, and every moist substance which becomes dry, produces living creatures, provided it is fit for their nourishment. The famous riddle with which Samson perplexed the Philistines: "Out of the eater came forth meat, out of the strong came forth sweetness," evidently expressed the idea that the bees which Samson found in the carcass of the lion he had killed had been produced *out* of the carcass. Indeed, the idea that bees could be produced artificially from the dead bodies of animals was believed in implicitly by the ancients, and we find a complete description of the method to be adopted in the Georgics of Virgil!

It is not hard to understand how in primitive times insects appeared to be generated spontaneously from corrupting matter, but on the other hand it is very difficult to imagine how the notion could have originated that the higher animals could be produced artificially. That such a belief prevailed is certain, for we find Van Helmont, a chemist of the 16th century, giving directions for manufacturing mice, and he even went so far as to maintain that fish are produced out of water.

Even in contemporaneous times the notion of spontaneous generation has found plenty of supporters, and it is not many years ago since it was gravely announced that a new insect—the *acarus electricus* (for it was even christened!) had been produced by means of the electric current, and I have often been told in country places that if horse hairs are placed in water each separate hair will become an eel!

The first to combat the doctrine of spontaneous generation

was the Italian Redi, who, by a very simple experiment, proved that flies are not produced spontaneously from putrefying meat. He merely enclosed fresh meat in a gauze cage, and observed that although the latter putrefied no maggots nor flies were developed *in* it. He watched the flies hovering over the enclosed meat, and by a mistaken instinct depositing their eggs in the gauze cage, and eventually he saw these eggs turn into maggots. He thus proved, by an experiment which we may agree with Huxley in calling childishly simple, that insects *are* produced from their parents and not spontaneously as a product of corruption. Redi's experiments were sufficiently conclusive with regard to the mode of genesis of the higher animals, but after the construction of the microscope had been improved, when, in fact, the compound microscope came into use, the question of spontaneous generation was again brought prominently forward. For the microscope revealed countless organisms in ordinary water, but especially in infusion of animal and vegetable substances, such as meat broth and an infusion of hay. These organisms, or "infusoria," as they were called, are characterised by their extreme minuteness; hence the question of their origin presented considerable difficulties. If we examine an organic infusion recently prepared no sign of a living organism is visible, but in a few hours the liquid teems with myriads of minute beings. Whence have they come? Are they produced spontaneously from the animal or vegetable substances present in the infusion? or are they the descendants of pre-existing beings which have gained access to the infusion in some way, are they formed from eggs or spores present in the water or in the substances from which the infusions have been made? The English observer Needham was the first to attack this problem experimentally. He argued that as heat destroys both the seeds of plants and the eggs of animals a boiled infusion ought not to develope any living organisms. He tried the experiment, *i.e.*, he heated the infusions in hermetically closed vessels, and found that subsequently organisms *did* develope; hence he came to the conclusion that they were spontaneously produced. After these experiments the Italian physician

Spallanzani took up Needham's work, and by heating the hermetically sealed infusions for a longer period arrived at the opposite result—no infusoria appearing after the prolonged heating. Needham, however, was prepared with an argument to explain this result, his contention being that under the conditions of Spallanzani's experiment the *germinating power* of the infusion had been destroyed, and further that the air contained in the closed vessel had been destroyed by the heat. The latter part of this criticism acquired some force when it was discovered that the gases contained in vessels of preserved provisions contained no oxygen, and oxygen is, as we know, essential to life. Swann, however, showed conclusively that if an infusion previously boiled is placed in communication with air that has been heated red hot, no putrefaction occurs. Ure and Helmholz multiplied Swann's experiments with the same result, and Schulz found that instead of calcining the air it is sufficient before admitting it to the boiled infusions to allow it to pass through energetic chemical substances, such as oil of vitriol, &c. These experiments were really sufficient to decide the question against the doctrine of spontaneous generation, but its supporters were hard to defeat, and clung tenaciously to their belief. Their objection at this stage of the controversy was ingenious, if nothing else. By calcining the air, or by passing it through energetic chemical substances, you destroy some principle in it which is essential for the production of infusoria, they said. It is all very well to say that you merely destroy the seeds or germs, but you offer no proof of such a thing.

This criticism had to be met, and it was met most ingeniously by Schroeder and Dusch, the method which they employed being simply a refinement of Redi's experiment with the gauze cage round the meat.

Instead of the gauze cage they used cotton wool, merely allowing the air to filter through it before coming in contact with the well boiled infusion. Under these conditions they found that the latter remained perfectly sweet and fresh, showing no trace of organisms when examined under the microscope, nor the slightest symptom of putrefaction, except in the case of

milk and eggs. It is, they argued, difficult to imagine that the wool can have removed anything from the air except solid particles, and these must be the germs of the infusoria.

It only remained to demonstrate, first, that these germs are actually present in air, and secondly, that they are retained by the cotton wool. Independently Tyndall and Pasteur devoted themselves to this branch of the subject, and arrived at positive results by two totally different methods.

In Pasteur's beautiful researches, which are remarkable for their simplicity, elegance, and aptness, ordinary air was filtered through cotton wool, and as thus purified was found to have lost its power of inducing putrefaction in organic liquids. Pasteur then submitted the minute residue which was left to microscopic examination. In it he had no difficulty in recognising the spores of minute organisms; and to complete the proof that these spores are actually the seeds of putrefactive organisms he brought them into a previously boiled infusion, and found that in the course of a few hours the liquid was in active putrefaction. Tyndall's experiments were based upon totally different considerations. Every one knows that when a ray of sunlight enters a dark room its path is clearly visible. The ray looks like a faint luminous cloud, and if the cloud is examined narrowly myriads of particles are seen to be floating in it. Now, Tyndall found that by allowing air to remain perfectly quiet and undisturbed for a day or two these particles by their natural gravity subside, and a ray of light when now passed through the air no longer shows any visible track. He proved by a simple experiment that air before subsidence causes organic infusions to putrefy, whereas after subsidence the infusion may be exposed for any length of time to it without undergoing the slightest putrefactive change.

We may, therefore, consider it as definitely proved that putrefaction is caused by minute organisms, the spores of which are present in air, and that it is not due to any spontaneous change occurring in the putrescible matter, nor to any specific action of the air as such. The minute organisms are produced from spores or eggs, and the doctrine of spontaneous generation we may consider as finally refuted.

The study of the causes of putrefaction has opened up a very wide field of research, and has thrown a flood of light on many phenomena which were formerly hidden in mystery. For careful enquiry has shown that the spores and seeds of minute organisms are almost universally present,—that they occur abundantly in air, water, and earth. Only some of them are concerned in causing putrefaction; others have equally well defined but totally different functions. Thus there is a set of organisms which have the power of inducing perfectly definite chemical changes in certain substances, and unconsciously they have been employed from time immemorial for the purpose. As an example we have the organism which causes the production of vinegar (acetic acid) from fermented liquids (which contain alcohol). Others again cause the production of various colouring matters, and some of these have not unfrequently excited the awe and wonder of the superstitious. For instance, there is the phenomenon of the "Bleeding Host," when bread has apparently become covered with blood. But far more important than any of these are the organisms which are undoubtedly associated in an intimate manner with certain diseases, often the very worst and most malignant to which men and animals are subject. I shall endeavour presently to show there are grounds for believing that in producing disease they are playing a chemical role, and it is by no means impossible that the chemical changes induced by them in the blood and secretions are the actual causes of the diseases in question. Before entering upon the discussion of some of these different organisms, which for our purpose we may arrange in four groups, viz.:—

(1) Putrefactive.
(2) Chemical.
(3) Chromogenic.
(4) Pathogenic.

I may be permitted to say a few words about their appearance,

life history, and the methods which have been invented for their study. The organisms in question are very numerous, and diverse in size and form. Naturalists have found much difficulty in assigning them to their proper kingdom; and, in fact, from time to time have transferred them from one kingdom to another; at one period considering them to be animals, at another vegetables. At any rate they are among the lowest types of life, and may be considered to be on the borderland between plants and animals; but at last they have been definitely claimed by the botanists.

They have as a class been called by different names. Haeckel termed them "Protista," Sedillot "microbes," and they include besides the different varieties of yeasts, moulds, and fungi, the so called "splitting fungi" (*spalt pilze*) or "schizomycetes," in allusion to their peculiar mode of reproduction. These latter are of especial importance, and I shall in the rest of this lecture deal with them exclusively.

The classification of the schizomycetes has not yet been definitely settled. It will be sufficient for our purpose to describe the appearance of some of the chief varieties.

Micrococci.—Minute round organisms, sometimes arranged in groups of two (dumb-bells, *dyspsococci*), or of four (*tetrad*), or in packets of tetrads (*sarcinci*). Very frequently they are found in chains (*streptococci*).

Bacteria and *Bacilli.*—The first short, the second longer rods, often arranged in groups of two, or in chains of many. They are frequently motile, darting about with great rapidity. The movement is caused by a whip-like appendage (*flagellum*) attached to one end of the organism.

Leptothrix.—Long filaments, often branching out in different directions.

Spirillum.—Organisms which are twisted, often like a corkscrew, and which move with great rapidity.

Modes of Reproduction.—The schizomycetes, as I have before mentioned, are so called on account of their peculiar method of reproduction, *i.e.*, by splitting in one or more directions, each fragment becoming a mature organism and again sub-

dividing. As this mode of reproduction occurs very rapidly, the actual rate at which these organisms multiply is something truly startling, and fully accounts for the rapidity with which putrefaction and similar phenomena progress when they have once been set in action. Indeed, it reminds one of the fable of the man who offered to sell his horse for a price to be determined by the nails in its hoofs—½d. for the first nail, 1d. for the second, 2d. for the third, and so on. You may recollect that if there were in all 24 nails, the horse would have fetched £34,947 9s. 4d. According to Cohn, under favourable conditions a single bacterium by growth and division could produce in 48 hours the enormous number of 281,500,000,000 individuals! And this rate of development, if carried on for five days, would give sufficient bacteria to fill the ocean. Another estimate is that the progeny of one bacterium which in the course of 24 hours only weighs $\frac{1}{50}$ milligramme, at the end of three days amounts to 7,500 tons. In point of fact, perfectly favourable conditions for the continuous development of these organisms are never actually realised, or at all events for any length of time; for the rapidity of their multiplication is at once checked as soon as the soil (if I may use the expression) in which they grow begins to be exhausted, and is eventually entirely stopped owing to this cause. Moreover, it would appear as if the substances excreted by the organisms themselves, if not removed, or at all events diluted, act injuriously upon them, and eventually cause their destruction, or at all events the cessation of their functions; just as we find that yeast ceases to grow in a sugar solution when the spirit reaches a certain strength, the spirit paralysing or destroying the vitality of the yeast cells. A curious fact in connection with this statement is that in many cases the substances produced by minute organisms are amongst the most active agents for their destruction. I fancy that nearly all excrementitious products are peculiarly fatal to the health of plants and animals producing them.

Apart altogether from the process of multiplication by fission, we find another distinct method of reproduction among the *schizomycetes*, or at all events among some of them. This

method is very analogous to the *ascospore* formation of yeast, and is evidently a provision of Nature's for preventing the organisms from becoming extinct under conditions unfavourable for their ordinary life and development. In spore formation the contents of the cell contract, and eventually a round spore is produced within the cell, which finally escapes. The spore placed under favourable conditions eventually germinates into a mature organism.

The resisting power of the spores to the action of agencies fatal to the existence of the organism from which they were developed, or into which they grow, is very striking, and fully accounts for the difficulties experienced in disinfection, and also for many of the mistakes which were made by the believers in the doctrine of spontaneous generation in interpreting the results of their experiments. Again and again they declared that organisms made their appearance in liquids which had been thoroughly freed from them. No doubt the organisms themselves were absent, but their spores were present, not having been destroyed during the preparation of the infusion. Thus the bacillus of hay infusion may be boiled in water for ten minutes without losing its vitality, and it may be soaked in pure carbolic acid and in other strong disinfectants without losing its power of germination. The resistance of these permanent spores to agencies which easily destroy the life of the mature organisms with which they correspond is a point of great importance with regard to infectious and contagious diseases (or at least to some of them), but I hope to touch on this matter later on.

There is only one other consideration I shall mention in connection with the morphology of the schizomycetes, but it is of importance, and may considerably modify many of the present views. It has been asserted again and again—and I think the eminent surgeon Loeher was among the first to make the statement—that certain of these organisms under special conditions undergo a metamorphosis of such a kind that a micrococcus can become a bacterium, the bacterium a bacillus, the bacillus a leptothrix thread, or a spirillum, &c.; in short, that in certain

cases an organism can assume various forms. Zopf, in especial, has maintained the existence of this pleo-morphism, and his system of classification is very much based upon the assumption. In his book he gives drawings taken from actual observations illustrating transformations of this kind. The possibility of these changes occurring adds to the difficulties—already very great—which are experienced in investigating these organisms; for what means have we of classifying a particular species if it can exist in various forms and be of different sizes? It is obvious that mere microscopic examination and measurement, which have up to the present time been relied upon in establishing the identity of an organism, completely lose their value. Besides, another set of questions are also raised by this new doctrine, which I may be able to refer to when I come to the consideration of the pathogenic species.

Having explained, as far as time permits, these few points connected with the life-history of schizomycetes, you will permit me to say a few words next relative to the conditions under which they thrive. Their tissues contain much the same primary constituents as are found in ordinary plants and animals —that is to say, the elements Carbon, Hydrogen, Nitrogen, and Oxygen, and in addition certain mineral substances among which are Lime, Potash, Magnesia, and Phosphoric Acid.

The juices of meat and of vegetables contain the nutriment for these minute organisms in the most readily assimilable form, hence we find them especially suitable for their nourishment, and not only is this the case, but it has also been shown that the various secretions of animals such as blood, saliva, milk, &c., are capable of serving as soils, in which (certain species at least of) organisms thrive well. Some of them, though possibly their number is restricted, can be grown in artificial solutions, such as Pasteur's fluid, but I think it may be stated as a rule that the schizomycetes require for their nourishment more complicated compounds than those which can be prepared in the laboratory. I mean they require albuminoid bodies, of which ordinary white of egg is an example. In this respect they resemble animals and not vegetables, as the latter have the power

of manufacturing for themselves albuminoid bodies out of simple compounds. The schizomycetes then thrive in liquids containing the necessary materials for their growth, but they also frequently live on solids, such as potatoes, white of egg, &c. Oxygen (in the free state) is essential to the lives of some, but not of all.

It is necessary for me to say a few words about the methods which have been devised for cultivating organisms in the pure state, and indeed our present knowledge of most of the really important facts connected with them depends very much upon the introduction of accurate methods for the purpose. For if we consider for one moment that the spores of countless species swarm in the air, and are present, unless suitable precautions are taken, in water and in animal and vegetable matter, we can easily see that the isolation and cultivation of one particular species is a difficult task: for how exclude the others? An agriculturist would be puzzled to know how to raise a crop of corn without any weeds whatever if he were not permitted to remove the weeds as they appeared. The Bacteriologist is called upon to do this, but the weeding operation is denied him. How has this difficulty been overcome? It is evidently essential in the first place to have a soil suitable for the growth of the organism we want to cultivate, and this soil must be free from other organisms or their spores; next, the organism we wish to cultivate, or its spore, must be introduced into the soil; and thirdly, the soil and the organism (or its spore) must be placed under suitable conditions for the growth of the latter; the experiment being so conducted that no adventitious organisms can make their entrance into the vessel in which the cultivation is proceeding.

We require then :—

(1) A suitable nourishing medium, which must be sterile (*i.e.*, free from organisms).

(2) The pure organism, free from other species.

(3) Suitable conditions as to temperature, &c., for the growth of the organism.

Now, in the laboratory various "soils" are made use of.

Beef tea, blood serum, infusions of turnip, cucumber, and other vegetables, Pasteur's solution, &c., and occasionally solids such as potatoes. But for the present we need only consider liquid media. When freshly prepared they usually swarm with organisms. This cannot be avoided; our only course is to destroy them. To do this the liquids are placed in suitable vessels (usually glass flasks or test tubes) the mouths of which are plugged with cotton wool. They are then heated to the temperature of boiling water, either by immersing them in steam or by boiling their contents. The heating is usually repeated on three consecutive days, so as to ensure the destruction not only of the organisms originally present as such, but also those which may have subsequently germinated from the more resisting spores. The liquids are now sterile, and no organisms can gain admission to them so long as the plug of cotton wool remains undisturbed. To prove the sterility, the liquids ought to be kept for some time, and should show no cloudiness or other evidence of change. We have next to introduce an organism or spore of the particular species we wish to cultivate, *free from any others of a different species.*

To do this was, for some time, an impossibility, for how pick out a single individual when to see it requires the highest powers of the microscope? We are indebted mainly to Koch for having solved this problem, and for having devised a beautiful and ingenious method which has marked quite an epoch in bacteriological science.

Koch takes a sterile nourishing medium containing gelatine, which when cold solidifies to a jelly.* He then introduces into the gently-warmed medium a droplet of liquid containing the organisms to be cultivated (but presumably other organisms also) and pours the mixture upon a glass plate which has been previously heated to a high temperature to destroy any organisms present in the dust on its surface. The plate is then put beneath a bell-shaped jar on blotting paper previously soaked in corrosive sublimate solution. By this means the jelly is kept moist, and at the same time protected from dust.

* Probably everyone knows that ordinary jellies "set" on account of the gelatine which they contain.

Consider the effect of this operation. The organisms present in the liquid with which the gelatine was inoculated are presumably equally distributed, and if only a few are present (which can be ensured by diluting the liquid used for inoculating) each individual is separated from another by a considerable space.

In course of time (only a few hours under favourable conditions) each organism reproduces itself, eventually producing a colony, and this colony *liquefies* the gelatine at a particular spot or causes an opacity. Hence we may be certain that liquid taken from this spot contains only one species of organism, and with this we can inoculate our sterile liquid and so obtain a pure culture. This beautiful method of Koch's has been employed by him for isolating and investigating many of the organisms of disease, and can be used for measuring the number of organisms in air, water, and other fluids.

Now, having inoculated our nourishing medium with the organism we wish to study, we have next to place it under favourable conditions for their growth, and as a rule that means a steady temperature (on an average about as high as that of our bodies). The apparatus used is called an "incubator," and is simply a box with double walls, the interspace being filled with water which is kept at a constant temperature by a gas flame, automatically controlled by a "thermostat," so that the temperature inside the box (where the culture is kept) never varies by more than a few degrees.

* * * * * * *

Such in a few words are the chief methods employed in "bacteriological" research, and with their introduction more

exact information has been obtained of many phenomena which previously were utterly obscure. Some of these phenomena I propose to examine.

Putrefaction.—This may be considered to be a beautiful device of nature's for disposing of dead organic matter, and for converting it into substances which can again serve for the nourishment of plants and animals. But for it this earth would be a vast charnel-house; we should be surrounded by the emblems of death, and not only so, but as the supply of substances suitable for the nourishment of plants and animals is limited, each race would gradually diminish the stock, which would eventually become exhausted and the world no longer habitable. As it is, however, no sooner does a plant or animal die or give up its excretions, than the remains are fastened upon by an army of scavengers, who gradually reduce them to simple compounds which are either dissipated in the air, washed away by water, or go to form earth. Every tyro in chemistry knows that every atom of matter is indestructible, "and in its time plays many parts."

Our army of scavengers are mainly organisms of the kind I have been describing, and although much has been done towards their study, much still remains to be done before we shall be able to say definitely what their exact functions are. Thus we do not know at present how many species there may be engaged in the work, nor do we know with any exactness how each species acts. It would appear, however, that putrefaction is by no means a simple process, and that before a complex substance like albumen or white of egg can be resolved into simple bodies like ammonia, water, and carbonic acid it has to be attacked by successive gangs of these minute labourers, each gang dying off after completing its share of the work and leaving things in order for the operations of the next.

If any putrefying substance is examined with the microscope, it is found to be swarming with organisms of nearly all the forms I have described, viz., *micrococci*, *bacteria*, *bacilli*, *spirilla*, *&c.*

Hauser has devoted much time to the study of putrefactive

organisms, and believes that two species are especially active, at all events in the earlier stages of the process. These he terms *proteus mirabilis* and *proteus vulgaris* respectively. They are remarkable for the variety of forms they can assume, and furnish an excellent example of *pleomorphism.* Hauser has illustrated his work on the subject with some very beautiful micro-photographs (taken from nature) of these organisms in their various stages of existence.

Many interesting and highly important observations have been made with regard to the nature of the substances produced during putrefaction. Thus it has been shown by Selmi and others that putrefying animal matter frequently contains certain substances closely resembling in their properties some of the most poisonous alkaloids found in the vegetable kingdom. These have been called *Ptomaines*, and their significance is very great when we consider that in certain cases of suspected poisoning, corpses are often exhumed and are examined for alkaloids among other poisons. It is by no means impossible that a ptomaine might be mistaken for a poisonous alkaloid, and thus a false suspicion or even conviction arise as to the cause of death.

Again, many cases of poisoning have occurred from the consumption of tainted meat, fish, cheese, &c. In such cases it is also possible that the poisonous principles are ptomaines. It has also been shown that "by the putrefaction of animal substances a body can be obtained—the septic poison or *sepsine*—which is isolated by various chemical processes destructive of every living organism, and which on injection into the vascular system of animals, especally dogs, in sufficient quantities occasions a marked febrile rise of temperature, and is capable of causing death." *

Organisms causing definite chemical changes.—It is conceivable that every species of micro-organisms induces perfectly definite chemical changes in the medium in which it thrives. There are, however, certain species which induce very simple chemical reactions, and many of the latter are every-day

* Klein.

phenomena which have long been noticed and even employed practically, although their cause was not understood. A few of these changes deserve our attention.

The Lactic Ferment.—Everyone knows that when milk is kept it becomes sour and curdles.

As early as 1780 the Swedish chemist Scheele extracted from sour milk a peculiar acid, which he named from its occurrence lactic acid. It is obvious that the souring of milk is due to the development of this acid ; but the question arises—From what special substance in the milk is it formed, and what is the cause of its development ?

Careful experiments have completely answered these questions. One of the chief constituents of milk is sugar, not exactly the same as occurs in the sugar cane, but one which is very analogous. This "milk sugar," as it is called, is extracted from the whey of milk (chiefly in Switzerland), and is a commercial product. Now it has been found that in proportion as milk becomes sour the quantity of this sugar diminishes, and under suitable conditions it disappears altogether. Further, if a solution of sugar is mixed with a few drops of sour milk, the sugar solution becomes sour and the acidity increases rapidly. It is, therefore, pretty clear that the development of lactic acid in milk is due to some transformation which the sugar suffers, and we have only to compare the formulæ of the two to see that a simple chemical relationship exists between them. In fact, every particle of sugar contains the necessary atoms to form two particles of lactic acid, and we may represent the conversion of the former into the latter by the following chemical equation :

$$\underset{\text{Sugar.}}{C_9H_{12}O_6} = \underset{\text{Lactic Acid.}}{2\,C_3H_6O_3}$$

But what is the cause of this transformation ? Pasteur, guided by his previous researches in alcoholic fermentation, sought for and found the lactic ferment which consists of minute rods or *bacilli*, which are often jointed or beaded. They can readily be seen in a droplet of sour milk with a $\frac{1}{4}$ inch power. By removing some of them from sour milk, and sowing them in a suitable

saccharine medium, he saw them multiply and produce all the effects of the lactic fermentation. As milk does not sour if taken from the cow in such a manner that no dust or solid particles can fall into it, there can be no question that its souring is due to the introduction of the spores of the ferment from dust or air.

The Butyric Ferment.—In a sugar solution which is undergoing lactic fermentation there is commonly developed, especially towards the close of the operation, another acid, which from its occurrence in rancid butter is called butyric acid. Pasteur investigated the causes of its production, and found that here again a minute organized ferment was at work, causing sugar to undergo a perfectly definite decomposition into butyric and carbonic acids and hydrogen gas. The change may be represented by the following equation :—

$$\underset{\text{Sugar.}}{C_6H_{12}O_6} = \underset{\text{Butyric Acid.}}{C_4H_8O_2} + \underset{\text{Carbonic Acid.}}{2\,CO_2} + \underset{\text{Hydrogen.}}{H_2}$$

This change is remarkable on account of the hydrogen which is produced, for I do not think there is any other instance known in which it is formed under the influence of a living vegetable organism. Advantage is taken of the circumstance in dyeing wool and cloth with indigo, the dyer employing a vat containing indigo diffused in water and a coarse kind of wheaten flour or bran. The starch which the latter contains is first transformed into sugar, which is eventually decomposed by the butyric ferment, and the hydrogen which is liberated converts the indigo into a colourless soluble substance which is readily absorbed by the wool, but which is again converted into the indigo and precipitated within the fibre when the wool is exposed to air. I may mention that sugar is not the only substance upon which the ferment acts, for it will also decompose tartaric, mucic, and malic acids, and convert them into butyric acid.

The butyric ferment resembles the lactic ferment in appearance, consisting of rods or *bacilli.*

The fact that sugar is capable of fermenting in three different ways, and that these fermentations occur spontaneously, leads

us to enquire why in grape juice alcoholic fermentation always occurs, whilst in milk we seldom if ever find the yeast organism, but always that of the lactic or butyric fermentation. Both liquids contain sugar, yet each undergoes a different fermentative change.

A little reflection will, however, enable us to understand the reason. We must remember that other things besides sugar are necessary for the proper growth of yeast, the lactic and butyric ferments. Thus we have seen that yeast requires certain mineral matters, and also certain nitrogenous substances, for its development, and it is the same with the lactic and butyric ferments.

We know that certain plants thrive best in particular soils and often become self-sown: thus the common sea pink flourishes in the immediate neighbourhood of the sea, but is not found inland. There is probably some peculiarity of the soil of seaside localities which fit it especially for the nourishment of that plant. In a precisely similar manner grape juice appears to be the liquid most suitable for the yeast organism, whilst milk probably contains those mineral and nitrogenous substances which are essential for the nourishment of the lactic and butyric ferments.

The Acetic Ferment.—I suppose that everyone knows that beer and wine when exposed to the air become sour, in fact produce vinegar, which is manufactured commercially by this very process. In proportion as the spirituous liquid grows acid it is found to lose spirit; hence it is obvious that the acid is produced from the spirit. The chemical name for the acid which is formed is acetic acid (from the Latin *acetum*, vinegar), and it is an elementary fact in chemistry that it can be produced by the oxidation of spirit. Thus

$$\underset{\text{Spirit.}}{C_2H_6O} + \underset{\text{Oxygen.}}{O_2} = \underset{\text{Water.}}{H_2O} + \underset{\text{Acetic Acid.}}{C_2H_4O_2}$$

It was originally believed that vinegar was produced by the simple chemical action of the oxygen of the air upon the spirit, and it was considered that the action was especially induced by porous bodies, which acted first as spongy platinum does, by condensing the oxygen and thus bringing it into closer contact

with the spirit. Pasteur has proved, however, that the determining cause of the oxidation is a definite ferment which has received the name of *mycoderma aceti*. It consists of minute rods or chains of rods, which often become felted together, forming a membrane somewhat like moist paper pulp to the naked eye, and this membrane is frequently found on the surface of the acidifying liquor, and is called the "mother of vinegar," or simply the "vinegar plant." Pasteur proved that the change of spirit into vinegar is really caused by the action of this ferment—and not by the simple action of the air—by a very elegant experiment. He allowed weak spirit to trickle down string (which is of course highly porous), and showed that in spite of its porosity no oxidation occurred, even after a month. He then steeped the cord in a liquid containing a pellicle of the mycoderma, some of which adhered to it, and then as before allowed the spirit to trickle down it, when it was rapidly acetified.

The manufacture of vinegar is carried out at Orleans in accordance with Pasteur's discoveries, the ferment being sown on the surface of the wine or beer. When the surface is covered with the membrane, the alcohol begins to acetify. From time to time fresh wine or beer is added, and when the acetification has terminated the membrane is collected, washed, and employed for a new operation.

I have not sufficient time to describe all the organisms which are capable of producing definite and well ascertained chemical reactions, and can merely mention one or two others. The ammonia ferment, which has the power of producing ammonia or hartshorn from urea, a substance abundantly excreted from carnivorous animals.

The nitre ferment, present in soil which oxidises ammonia to nitric acid.

The glycerine-ethyl ferment, which converts glycerine into spirit, &c.

Organisms causing the production of colouring matters.—Certain organisms belonging to the group of schizomycetes have the property of producing definite colouring matters,

either in their own tissues or in the medium upon which they grow. At times the sudden and spontaneous appearance of these organisms has created much wonder and awe. Thus, in 1819, "a peasant at Liguara, near Padua, was terrified by the sight of blood stains scattered over some polenta which had been made and shut up in a cupboard on the previous evening. Next day similar patches appeared on the bread, meat, and other articles of food in the same cupboard. It was naturally regarded as a miracle and a warning from heaven until the case had been submitted to a Paduan naturalist." *

The cause was found to be due to a minute organism to which the name *micrococcus prodigiosus* was given. It has been found in milk, paste, and even sacramental bread, where its appearance was of course considered miraculous. The colouring matter is not contained in the organism itself, but is produced by it in the medium in which it thrives. It somewhat resembles aniline red (magenta or rosaniline) in its properties.

Red Snow and *Blood Rain* are probably due to the same or to a similar organism. At times milk is found to be quite blue—a phenomenon of frequent occurrence on the German coast of the Baltic. Formerly it was attributed either to a diseased condition of the cow or to its consumption of vegetables containing indigo. Fuchs, however, showed that it was caused by an organism to which the name of *bacillus cyanogenus* was given.

Many other colour-producing organisms have been discovered, of which the following may be mentioned :—

Bacterium synxanthum, in yellow milk.

Micrococcus aurantiacus, occasioning orange patches at times on cooked vegetables.

Micrococcus chlorinus, producing green patches occasionally on cooked vegetables.

Micrococcus violaceus, &c.

Any one can obtain these organisms (or at least some of them) by exposing slices of potato (cut from potatoes well boiled in their skins) for an hour or two to the air, and then preserving

* Troussart, Microbes, moulds, &c.

them under glass bell jars (ordinary propagating glasses do admirably) on blotting paper moistened with weak corrosive sublimate solution. The spores of the organisms are deposited from the air on the potato slices, and after a few days develop into coloured particles or colonies which rapidly increase in size.

Organisms of Disease.—I come now to perhaps the most interesting and important part of my subject, viz:— to the connection which exists between certain organisms and some of the most serious diseases to which men and animals are prone.

That such a connection does exist has, I think, been very clearly and definitely established, and the question which now presents itself to medical men is not so much, are any diseases caused by organisms? but rather what diseases are not caused by them? I shall endeavour as briefly as possible to explain the facts and arguments which have led scientific men to the conclusion that certain diseases are caused by the introduction into the system, and subsequent development, and rapid multiplication of particular species of the schizomycetes.

I believe that the first observation tending in this direction was made by two French doctors, Messrs. Rayer and Davaine, to the effect that the blood of animals dead of splenic fever teems with minute rod-like bodies resembling the bacilli found in hay infusion.

This disease is one of the most deadly of those which are incidental to live stock, either sheep or oxen, and is remarkable for the suddenness of its appearance, and the rapidity of its action. A day or two, or in many cases only a few hours elapse from the time of its first symptoms to the fatal termination. Man at times is subject to it—especially those who are engaged in handling raw wool—whence the name "wool sorter's disease," or "malignant pustule" as it is also called.

Rayer and Davaine made their observation in 1851, but at the time they do not appear to have laid any great stress on it. It was subsequently confirmed in Germany in 1857, by Pollender and Brauell. At that time, however, the entire subject of micro-organisms was in its infancy, their nature and effects were not understood, and no doubt it would have appeared

ludicrous to assume for a moment that a minute organism, quite invisible to the naked eye, could attack and slay in a few hours a huge animal like an ox. But after Pasteur's memorable researches in 1861, on the ferment of sour milk, it was clearly shown that in spite of their minuteness, micro-organisms can produce very marked and extensive effects, even in a large quantity of matter, and Pasteur's work impressed Davaine so strongly with the potency of micro-organisms, that he once more returned to his observations of 1851, and became impressed with the belief that the bacilli observed in the blood of animals dead of splenic fever were no mere accidental accompaniments of the disease, but its actual cause.

The hypothesis having been introduced that this particular disease was really the work of micro-organisms, it was only natural that they should be sought for in other ailments of a similar kind, and the result has been a very distinct and important gain to medical science. It is possible that the new theory has fascinated medical men too much, and that they have too readily convinced themselves that diseases of all kinds are caused by organisms. It must, however, be borne in mind that investigations into the cause of disease are extremely difficult, and that the results are at times extremely uncertain and misleading. I think you will very naturally feel inclined to make this remark—of course I mean if you are not acquainted with the subject.

It is all very well to say that splenic fever is caused by organisms because they are found in the blood of the animals dead of the disease, but are not organisms almost universally present, and may not their occurrence in the blood of the animals be rather the effect than the cause? Do not they appear simply because putrefaction (or some modification of it) has already commenced?

The question is perfectly fair and logical, and has probably occurred to every one who has thought about the subject. Something more must indeed be shown besides the mere fact of the presence of organisms in the blood or tissues of an animal dead of the disease. In fact before we can credit so startling a

statement that the disease is caused by the organisms, we must be shown a most convincing and complete chain of proofs.

Such a chain of complete proof seems to have been established. As regards splenic fever, it is somewhat as follows :—

1st. We always observe in the blood and tissues of animals suffering from the disease, rod-like organisms or bacilli.

2nd. It is possible to inoculate (with every precaution) an artificial nourishing medium—say nutrient gelatine—with this blood, and we find characteristic colonies from which we can obtain a pure culture of the bacillus, with which we can inoculate a sterile nourishing fluid like broth.

3rd. On injecting this broth into a healthy animal—a mouse, a guinea pig, a sheep, or an ox, we find after a short interval all the characteristics of splenic fever. The animal usually dies, and in its blood are found countless bacilli of the kind from which we originally started.

The argument appears complete, and I believe that Koch was the first to maintain that no organism could be considered as the cause of a disease, unless all the above conditions are fulfilled.

Koch has formulated the above conditions, thus—

(1) It is absolutely necessary that the micro-organisms in question be present in the blood or diseased tissues of man or animal suffering or dead from the disease. [In this respect great differences exist, for in some infectious diseases the micro-organisms, although absent in the blood are present in the diseased tissues, whilst in others they are present in large numbers in the blood only, or in the lymphatics only—Klein.]

(2) It is necessary to take these organisms from their nidus—from the blood or tissues as the case may be—to cultivate them artificially, *i.e.* outside the animal body, but by such methods as exclude the accidental introduction into these media of other micro-organisms ; to go on cultivating them from one cultivation to another, for several successive generations, in order to obtain them free from every kind of matter derived from the animal body from which they have been taken in the first instance.

(3) After having thus cultivated the micro-organisms, it is necessary to re-introduce them into the body of a healthy

animal susceptible to the disease, and in this way to show that the animal becomes affected with the same disease as the one from which the organisms were originally derived.

(4) It is necessary that in this so affected new animal the same micro-organisms should again be found. " A particular organism may be the cause of a particular disease, but, that really and unmistakably it is so can only be inferred with certainty when every one of the above conditions are fulfilled." (Klein.)

You will allow me to glance for a few moments at some of the most important diseases which have been thus shown to be intimately associated with micro-organisms.

Tuberculosis.—This terrible disease, of which so many sufferers die a lingering death, was proved by Koch to be due to a particular species of rod-like organism, which is called in consequence *bacillus tuberculosis*. They are a great deal shorter and thinner than the bacilli of spleen fever. Koch showed that they occur in all tubercular growths of men, monkeys, cattle, birds, and other animals, and in man they are found in the blood and sputum. It is possible to cultivate them in an artificial nutrient medium, best in solid blood serum; and the disease can be communicated to a healthy animal by injecting such a culture into its system. In guinea-pigs and rabbits the disease requires a period of "incubation" of three weeks and more; that is to say, this period intervenes between the time of inoculation and the first symptoms of the disease. It has been shown by inhalation and feeding experiments that animals can be inoculated; and as the bacilli themselves require a high temperature for their development it is probable that the disease is spread either by the inhalation of the spores or by their being swallowed with the food.

Cholera is one of the most dreaded of all diseases. Fearful for the wholesale slaughter it causes when a locality is once, so to speak, in its grasp, and fearful also for the terrible rapidity of its action. It is said to originate in the valley of the Ganges, where it is permanent or endemic, and yearly it spreads over India. In Europe it first appeared at the commencement of

the present century, since when there have been six visitations. The first indications that cholera is caused by an organism were the result of the researches of the French and German commission sent to Alexandria in 1883 to investigate the disease. Koch, a member of the German commission, discovered it, and called it the "comma" bacillus, from its peculiar curved shape. The bacillus is found in the intestine, but not in the blood ; it can be cultivated on nutrient gelatine, and Koch has observed that it readily multiplies in most articles of food, and even in damp linen. It requires a fairly high temperature for favourable development, but cold does not kill it. Koch also found the organism in the stagnant waters of certain cholera-stricken districts, and also in a tank, the water from which had apparently produced the disease in several people who had used it for drinking purposes. As soon as the bacilli disappeared from the water, cholera cases ceased.

I believe that there is still some doubt as to this organism being the cause of the disease, as inoculation experiments have only been of very doubtful success. It has been asserted that cholera has been communicated experimentally to guinea-pigs ; but others have maintained that these animals did not show the typical symptoms. Bochefontaine, of Paris, swallowed pills containing choleraic matter ; but although he felt unwell for some days no serious symptoms arose.

Many other diseases are believed to be due to organisms, and of these I may enumerate the following :—

Name of Disease.	*Nature of the Organism.*
Diptheria	Micrococcus
Erysipelas	"
Pneumonia	Bacteria
Leprosy	Bacillus
Glanders	"

Organisms present in the system in health.—As the air we inhale, the food we eat, and the water we drink, usually teem with organisms, we are constantly introducing myriads of these minute beings into our systems. Indeed, Miquel estimates the number of spores introduced into the mouth at 300,000 a day! The fact would lose some, at least, of its repugnance if we were assured that when once introduced they would perish, but such is not the case, as any one can see for himself by examining a droplet of saliva under the microscope, when it will be found to swarm with all kinds of organisms, micrococci, bacilli, spirilla, leptothrix, &c. In fact the entire track of the alimentary canal appears to be a kind of garden in which organisms find a suitable soil for their growth and development. It has even been asserted that certain species aid in the processes occurring within our bodies, and assist digestion, &c. Thus we are surrounded by an invisible host of organisms, some deadly, some possibly of service to us. We offer admittance to all, but we expect the deadly not to enter, and broadly speaking we are immune from them. The doctor can enter a fever ward without infection. A family may breathe the same air and only one of its members is stricken with consumption. A Sister Dora (and for that matter many a physician whose name we never hear of) can suck a tracheotomy tube, and yet without catching diphtheria. We are almost confident now that in each of these cases a disease organism enters the systems of all concerned. "Two women shall be grinding at the mill, one shall be taken, and the other shall be left." At present I believe no satisfactory explanation can be given of immunity.

Let me return for a moment to the organisms present in the mouth. Adhering to the teeth are always to be found thread-like organisms called *leptothrix buccalis*. They are supposed to cause the decay of teeth, and there can be no doubt that microscopic examination shows that the decayed parts are full of organisms. Another very singular fact connected with the organisms found in the mouth, is that very often virulent species are present, that is to say human saliva when injected into healthy animals, such as rabbits, produces grave affections often terminating in

death. The blood of the animals thus infected is full of micrococci, and these can be cultivated by the ordinary methods. The virulence of saliva differs considerably in different individuals.

Action of disease organisms.—Many questions arise from the discovery of the connection between organisms and disease, especially regarding the nature of their action upon the system. It has been definitely proved, as I have explained, that many species produce in the nourishing medium definite chemical substances, some of which are excessively poisonous. Are the diseases which are believed to be caused by organisms due to the production of such poisons within the body; or are the blood and other secretions so altered in the nature as to be unfit for the proper performance of their functions; or are the diseases caused by a merely mechanical action of the organisms in plugging the minute blood vessels, and thus interfering with circulation? In fact, do the organisms act chemically or mechanically?

I do not see how these questions can be definitely answered until the chemist submits them to a very searching experimental enquiry. He ought, in the first place, to investigate the chemical action of each disease organism; to grow them in various nutrient media, and to investigate the nature of the substances they give rise to in each case. If such substances, when freed from the organisms which produce them, are found, when injected into healthy animals, to cause similar effects to those produced by the diseases themselves, the question will be decided.

There is an indication at least, if nothing more, that in certain diseases it is the virus produced by the organism which acts, and not the organism itself. Thus in spleen fever it often happens that death is so rapid that only few bacilli occur in the blood—quite too few either to cause the plugging of the small vessels or to remove the oxygen from the blood, and thus to deprive the system of that element.

Recovery from disease.—Another question which presents itself to our minds is this—How is it that if an infectious disease

is caused by organisms, and such organisms we know can be cultivated for any length of time in a suitable nourishing medium outside the body (provided it is renewed from time to time); how is it, I say, that we ever get rid of the disease? For our blood and tissues are constantly being renewed; a suitable pabulum is thus maintained for the continued growth of the disease organisms, and therefore it would seem that when once introduced they should continue to exist and never be got rid of. But we know that the contrary is the case, at least as a rule. Either the patient dies or recovers (quickly very often) and loses all trace of the malady. How can his recovery be accounted for?

The explanation may be as follows:—We know that organisms multiply very quickly in a suitable medium, and that the substances they produce are in many cases singularly antagonistic to their existence. The yeast cell is killed when immersed in a solution of spirit of a certain strength, and indol, skatol, and phenol, bodies which are produced by certain putrefactive organisms, are among the most powerful agents in *arresting* putrefaction. Therefore it is not impossible that the disappearance of an infectious disease and the recovery of the patient may be due to some such action: the organisms causing the disease multiplying rapidly up to a certain point, until, in fact, they have produced so much of their peculiar virus that it reacts upon themselves, and poisons off the whole crop.

But there is another explanation which is perhaps more satisfactory. We know that organisms require certain definite substances for their nourishment, and that therefore they thrive in a culture fluid only so long as these substances are present. Let us suppose that in the tissues of a healthy individual, a small quantity only of one of these principles is present: he catches an infectious disease, organisms are produced in abundance in his system, and rapidly use up this small quantity, then it is exhausted, the organisms no longer thrive, and eventually perish. It may be that a very long time will elapse before the convalescent can again accumulate the particular principle which

the organisms have used up, and during that period he will suffer immunity from the same disease. This, as every one knows, is very often the case.

Protection from disease.—Another question presents itself to us, and perhaps it is the most important, from a practical point of view, of any we have discussed. It is as follows :—

Granted that infectious diseases are caused by organisms, then, surely as we know what is required for their nourishment, and what is antagonistic to their existence, we ought to be able to devise some means for preventing their ravages among men and animals. An answer in the affirmative to part of this question was (to a certain extent) anticipated long ago, though unconsciously, by the introduction of vaccination as a preventive of smallpox. Perhaps few people know how ancient this operation is, for it appears to have been known to the Arabs and Chinese as early as the 10th century, and was also practised in India by the Brahmins, a public crier announcing that he had smallpox virus to sell. It was introduced into England I may say accidentally in George the First's reign.

The principle of vaccination is to give (by inoculation) a mild type of small-pox, which has the effect either of rendering the individual vaccinated entirely secure from an accidental attack of the malady, or in case he does take the disease to very materially moderate its violence. To Pasteur belongs the triumph of having proved that the vaccination method can be extended to other diseases incidental not only to man but to animals also. Thus with spleen fever or anthrax he prepares vaccine matter by cultivating the bacillus in an artificial medium for a considerable time at a high temperature. By this means it becomes "attenuated."

"At the end of a week the culture which at first killed the whole of ten sheep which had been inoculated with it, now only killed four or five, and in ten to twelve days it ceased to kill any—merely giving them a mild form of the disease and protecting them from further attack"—proved by inoculating them with the virulent virus. "The vaccine thus obtained in

Pasteur's laboratory is now distributed throughout the world, and has already saved numerous flocks from almost certain extinction."* Pasteur proceeded in a precisely similar manner in preparing a vaccine for fowl cholera—a very fatal disease incidental to poultry. Another method for preparing a vaccine fluid for various diseases, consists, so to speak, in passing the disease in question from one species of animal to another; the second species (in certain cases) taking only a slight illness, and then becoming protected against the virulent form. "Thus while the bacillus (from the blood) of sheep or cattle dead of anthrax invariably produces death when inoculated into sheep or cattle, after passing through white mice loses its virulence for those animals. The blood of white mice dead of anthrax does not kill sheep, but only produces a transitory illness, and the animals are for a time at least protected against the virulent disease." (Klein.)

Pasteur, in his now famous experiments on hydrophobia, at first made use of a similar method. He proved first of all that the disease is to a large extent localised in the nervous system. Thus a healthy dog is very rapidly inoculated by exposing its brain, and then inoculating the surface of that organ with a particle of the brain of a rabid animal. To attenuate the virus he inoculated a rabbit's brain with a morsel of the brain of a mad dog, then passed the disease from the rabbit to a monkey, whence it became attenuated, and a protective vaccine for dogs. His present method is quite different, and consists in inoculating with the crushed spinal cord of a rabbit dead of hydrophobia, the cord being previously exposed to pure air for a certain number of days.

Antiseptics and *Disinfectants.*—It has long been known that various chemical substances prevent and arrest putrefaction, and hinder the spread of infectious diseases. In fact, that such was the case was known long before the "germ" theory had been introduced. As soon as it was discovered that putrefaction and infectious diseases are closely allied, and are both caused by

* Troussart.

living organisms, the reason for the action of antiseptics and disinfectants became intelligible. It then became apparent that they act as poisons on the organisms

I do not desire to detain you long on this subject, but there are certain points connected with it of considerable importance which I ought to touch upon. If we take a putrefying liquid and add to it a very small quantity of carbolic acid, corrosive sublimate, chloride of zinc, &c., the putrefaction stops. The organisms are poisoned, and consequently they perish. Similarly, after a case of an infectious disease, sulphur is burnt in the room occupied by the patient, or chlorine is evolved from bleaching powder, everything is well washed with carbolic acid, and the bedding is burnt.

Have all the disease organisms or their spores been destroyed? I am decidedly of opinion that they have not, and chiefly for this reason: that the *spores* of an organism have an extraordinary power of resistance to destructive agencies. Thus the spores of the hay bacillus can be completely dried, and can actually be boiled with water for a considerable time without losing their vitality. It might be argued that the hay bacillus is not a disease organism, and that the latter are more easily destroyed. Possibly this is the case with some, but certainly not with others. Thus it has been proved that a solution of corrosive sublimate—the most powerful antiseptic we are acquainted with—stops the growth of the spores of bacillus anthracis, even when the solution contains only one part of corrosive sublimate to 300,000 of water. But, on the other hand, the spores have not lost their vitality, for Klein has shown that they may be soaked in a one per cent. solution of corrosive sublimate for twenty-four hours, and yet when removed and injected into animals the latter soon die of tpyical spleen fever.

Several years ago Professor Fuller and I tried a number of experiments on the action of gaseous antiseptics, such as chlorine, bromine, the fumes of burning sulphur, ozone, &c., on putrefactive organisms, or rather on their spores, and we were simply astonished at their power of resistance. Bromine ap-

peared to be the most active disinfectant; and I think it might be used with advantage as a substitute for the fumes of burning sulphur, which in our experiments appeared to have no appreciable effect.

It appears to me that a series of complete experiments should be tried with different antiseptics on the spores of each of the disease organisms, for in the absence of the information which would thus be gleaned it is impossible to say how far disinfection is of service. It is perfectly within the bounds of possibility that great differences in the resisting power of the spores of various organisms exists, and that in some cases disinfection is of real service, whilst in others it is mere waste of time.

5th April, 1887.

W. H. Patterson, Esq., M.R.I.A., in the Chair.

R. Lloyd Patterson, Esq., J.P., F.L.S., read a Paper entitled,

SOME ACCOUNT OF THE WHALE AND SEAL FISHERIES, PAST AND PRESENT.

The reader commenced by giving a brief historical sketch of the whale-fishing industry, which he said had been discovered or invented by the inhabitants of the Basque Provinces of Spain, in the Bay of Biscay, as early as the 12th century. A whale still figures in the coats of arms of some of the Basque towns; and, long after that portion of the whale fishery which had been prosecuted with much success by the Basques had ceased to exist, the English and Dutch whale-fishers continued to employ Basques as harpooners or "whale-strikers," as they are called in the still extant accounts of Baffin's celebrated voyage, when twenty-four of these men accompanied the expedition in that capacity. After describing at some length the pursuit and capture of the pilot whale (*Globicephalus melas*) at the Faroe Islands, where several hundred of these comparatively small cetaceans are sometimes taken at a single drive, the lecturer alluded to the flourishing state of the Newfoundland whale fisheries up to and about the years 1785 and 1786, when Government paid a bounty of 40s. per ton to each vessel of two hundred tons or upwards engaged in it, and when the number of vessels amounted to between two and three hundred. The trade continued highly prosperous for many years, but from 1840 or thereabouts it declined, owing to the diminishing numbers of the whales and the lower value of the oil, and lost or worn-out vessels were not replaced. The trade languished

up to about 1860, when the application of steam-power to the ships gave it a fresh start, as the vessels were thus enabled to penetrate to higher latitudes and to follow the "fish," as they are called, into previously almost inaccessible haunts. Vessels now go out on combined sealing and whaling voyages. Proceeding first to St. John's, Newfoundland, they ship from two to three hundred extra hands for the sealing voyage. The young seals are born on the ice from about the 15th to the 25th of February, and the aim of the sealers is to find these young seals when they are three to four weeks old, as the oil they then yield is superior to that at any other period of their growth. At this stage of their growth they are called "white-coats," and in the vernacular of the island their pursuit is called "swile huntin'," the hunters being known as "soilers," a corruption of sealers. Mr. Patterson gave a graphic description of the manners, food, and clothing of these men, of their perilous occupation and the chances of success or failure. One vessel, if she be fortunate, may return to port in two or three weeks with thirty to forty thousand young seals on board; while another vessel, equally well found, if unlucky, may be twice the time out and return to port "clean," as it is called, that is empty, having been entirely unsuccessful. Many instances of this were given, and the vessels and their captains mentioned by name, special mention being made of Captain Guy, of the s.s. "Arctic," a native of Larne. After returning from the sealing voyage the vessels refit and proceed to their summer whale-fishing, which is carried on in the usual manner. On this whaling voyage in 1884 several of the Dundee fleet took part, for some time, in the search for the missing United States expedition under the command of Lieutenant Greely. Frequent and most appreciative mention is made of these bold and dashing whaling captains in Commander Schley's published account of the expedition which discovered and rescued Greely and the small remnant of his crew, only seven remaining alive out of the party of twenty-four. The lecturer then gave statistical particulars of the vessels engaged in the trade, and the results of their operations were given for the last six years,

Mr. Patterson mentioning the catches of this present season by the s.s. "Terra Nova" and another vessel. Five of the Dundee and Peterhead fleet were lost last year. For these particulars Mr. Patterson said he was indebted to his friend Mr. George Halley, of Dundee. After some mention of the seal, whale, and walrus fisheries, carried on principally by the Norwegians in European Arctic waters, the lecturer gave an interesting account, derived from his friend Mr. Henry Seebohm, of an important whale fishery that is carried on by steamers, with their headquarters on land on the Varanger Fiord, between Norway and Russia, and also mentioned an important shark fishery that is prosecuted with much success and profit near Iceland. Mr. Patterson next gave a brief account of the abundance of seal life on the Alaskan coasts and Aleutian Islands, in the North Pacific and Behring's Sea, and concluded his paper by a description of the pursuit and capture of the fur seals on the Pribylov Islands, St. Paul's, and St. George, where these creatures are to be found in myriads during the season; but a wise restriction as to the numbers that may be taken is preserving the race from that annihilation that seems to be threatening the seals in other places.

At the conclusion of his paper Mr. Patterson exhibited the skull of a very rare cetacean, the White-beaked Dolphin, *Delphinus albirostris*, the only example of the species the capture of which has been recorded in Ireland. This occurred at Donaghadee, and the record of the capture was made by Mr. M'Gowan of that place.

5th April, 1887.

W. H. Patterson, Esq., M.R.I.A., in the Chair.

Conway Scott, Esq., B.E., read a Paper on

EPIDEMIC DISEASES: CAN THEY BE STAMPED OUT?

In the course of his remarks Mr. Scott said that the great characteristic property of infection is its innate power of reproducing itself or multiplying itself without limit, and, under certain circumstances, without the slightest loss of its deadly qualities. Milk is a medium by which disease is very frequently communicated to persons, and the infinitesimal amount of infection falling into milk has multiplied itself so as to fill the whole milk supply, every glass of which can carry the disease as readily as the original matter. On the whole, there can be little doubt but that the human race has suffered infinitely more from epidemic diseases than from all the wars that have ever been engaged in and all the battles that have ever been fought. The lecturer went on to speak of the organic nature of all epidemic diseases, and said that the late Dr. Ritchie, who was one of the largest-minded scientific men that Ulster had ever produced, was a most thorough believer in the organic nature of all epidemic diseases, and that he more than forty years ago, when these subjects were hardly ever thought of, applied his practical knowledge to the stamping out of such diseases with great success. Mr. Scott then went on to deal with the different modes of disinfection, which means any process by means of which organisms of all kinds are killed, as every process which can kill ordinary organisms will to a much greater extent kill these disease-producing organisms, which cannot be seen, and are only

known by their fatal consequences. If you want to kill any organism, from the highest to the lowest, put it into a fire or furnace. The organism is completely taken up and reduced to gases and vapour, and every spark of life is extinguished. The liquid mode of disinfection consists in surrounding the infected matter with some liquid containing any substance in solution which has the property of killing an organic body. He illustrated this by stating that all the fishermen in a district, with their rods, nets, and lines, cannot destroy all the fish in any particular lake ; but if the contents of some flax dam be emptied into the lake, all the fish, young and old, large and small, will soon be dead, killed or poisoned by the action of the flax-water. The aërial mode of disinfection consists in surrounding and filling the pores of the infected matter with a sufficient volume of gases or vapours which have the property of killing all the disease organisms contained in the infected body or mass of matter. It is impossible to over-estimate the extraordinary effect that even slight changes in the aërial surroundings or environments have upon every organism, from a man down to the disease-producer. The lecturer then proceeded to explain the properties of the different liquids and gases commonly used for disinfecting purposes, referring especially to carbolic acid, whose characteristic property is its extraordinary power of destroying the lowest forms of life. Carbolic acid vapour can be generated by pouring the liquid acid into a hollow tin heater which has been raised to a very high temperature in any ordinary fire, and large quantities of that vapour can be thus thrown off in a very short time. In fact, there is no practical difficulty in generating any quantity of that vapour in any place where there is sufficient fire to heat up the little machine to which he referred. That vapour does not attack the metals, and does not destroy articles exposed to it ; and when moderate quantities of it are used it has no injurious action on the human or animal system, being thus unlike all the other disinfectants of that class. After many years' experience in small-pox, typhus fever, scarlatina, and diphtheria, he can with

confidence recommend this vapour as the most certain means of killing all the organisms which produced epidemic disease. As a matter of fact those organisms cannot exist for any length of time in an atmosphere of carbolic acid vapour. The lecturer then dealt with the disinfection of solid bodies, and gave a number of practical examples of the great utility of carbolic acid vapour as a disinfectant. In a man of drunken or dissipated habits the disease will probably attack him, because his diseased system offers the readiest hiding-place to those organisms. If a man be in a state of fear or nervous apprehension he is nearly sure to take the disease. The fear will reduce his system, and enable the disease to take hold on him. The lecturer concluded by saying that he would on a future date continue the subject, which is an all-important one, and deal with other branches of the subject of epidemic disease.

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Robertson, William, J.P., Netherleigh, Strandtown, do.
Robinson, John, St. James' Crescent, do.
Rowan, John, York Street, do.

Shillington, Thomas Foulkes, Castleton Park, do.
Simms, Felix Booth, Prospect Terrace, do.
Sinclair, Thomas, M.A., J.P., Hopefield, do.
Smith, John, Castleton Terrace, do.
Smyth, Travers, Sandymount, do.
Smyth, John, Jun., M.A., C.E., Milltown, Banbridge,
Steen, Robert, Ph.D., Academical Institution, Belfast.
Steen, W., Fitzroy Avenue, do.
Suffern, John, Windsor, do.
Suffern, William (Representatives of), do.
Swanston, William, F.G.S., Cliftonville Avenue, do.

*Tennent, Robert (Representatives of), Rushpark, do.
*Tennent, Robert James, J.P., D.L., (Representatives of), Rushpark, Belfast

*Thompson, James, J.P., Macedon, Whiteabbey.
*Thompson, Nathaniel (Representatives of).
Thompson, Robert, J.P., (Representatives of), Fortwilliam Park, Belfast.
*Thompson, William, (Representatives of), Belfast.
Torrens, Mrs. Sarah H., Edenmore, Whiteabbey.
*Turnley, John (Representatives of), Belfast.

Valentine, G. F., The Moat, Strandtown, do.
Valentine, James W., Cromwell Terrace, do.

Walkington, D. B., Thornhill, Malone.
Walkington, Thomas R., Laurel Lodge, Strandtown, Belfast.
Wallace, James, Ulster Bank, do.
Ward, Francis D., J.P., M.R.I.A., Clonaver, Strandtown, do.
Ward, Isaac W., Colin View Terrace, do.
Whitla, Wm., M.D., College Square, do.
Wilson, James, Old Forge, Dunmurry.
Wilson, John K., Marlborough Park, Belfast.
*Wilson, Robert M., Dublin.
Workman, Francis, College Gardens, Belfast.
Workman, John, J.P., Windsor, do.
Workman, Rev. Robert, Glastry, Kirkcubbin.
Workman, Rev. Robert, Newtownbreda. Belfast.
*Workman, Thomas, J.P., Craigdarragh, do.
Workman, William, Nottinghill, do.
Wright, Joseph, F.G.S., York Street, do.

Young, Robert, C.E., Rathvarna, Belfast.
*Young Robert Magill, B.A., Ardgreenan, do.

HONORARY ASSOCIATES.

Robinson, Hugh, Clive Villas, Belfast.
Stewart, Samuel A., F.L.S., North Street, do.
Tate, Professor Ralph, F.G.S., F.L.S., Adelaide, South Australia.

ANNUAL GUINEA SUBSCRIBERS.

Barklie, Robert, F.C.S., Working Men's Institute, Belfast.

Bruce, James, J.P., D.L., Thorndale House, do.

Carr, James, Rathowen, Windsor, do.

Corry, Sir James Porter, Bart., J.P., M.P., Dunraven, Windsor, Belfast.

Craig, James, J.P., Craigavon, Strandtown.

Dunville, Robert G., J.P., D.L., Redburne, Holywood.

Glass, James, J.P., Carradarragh, Windsor, Belfast.

Graham, O. B., J.P., Larchfield, Lisburn.

Loewenthal, J., Ashley Avenue, Belfast.

Luther, William, M.D., Chlorine House, do.

Lynn, William H., C.E., R.H.A., Crumlin Terrace, do.

Marsh, John, Glenlyon, Holywood.

Matier, Henry, J.P., Dunlambert, Fortwilliam, Belfast.

Mulholland, J. R. T., J.P., Northumberland Street, do.

Murray, Robert, Corporation Street, do.

M'Auliffe, George, J.P., Scoutbush, Greenisland.

Oakman, Nicholas, Prospect Terrace, Belfast.

Pim, Joshua, Slieve-na-Failthe, Whiteabbey.

Pring, Richard W., Firmount, Fortwilliam Park, do.

Reade, Robert H., J.P., Wilmont, Dunmurry.

Redfern, Professor Peter, M.D., F.R.C.S.L., Lower Crescent, Belfast.

Reeves, Right Rev. Dr., Lord Bishop of Down and Connor and Dromore, Conway House, Dunmurry.

Rogers, John, Windsor Avenue, do.

Ross, William A., The Ivies, Craigavad.

Stannus, A. C., Greenisland.

Taylor, Sir David, J.P., Bertha, Windsor, Belfast.

Taylor, John Arnott, M.A., J.P., Drum House, Dunmurry.

Tate, Alexander, C.E., Longwood, Whitehouse.

Watt, R., C.E., Victoria Street, Belfast.

Webb, Richard T., Greenisland.

Wolff, G. W., The Den, Strandtown, Belfast.

Report and Proceedings

OF THE

BELFAST NATURAL HISTORY & PHILOSOPHICAL SOCIETY

FOR THE

SESSION 1887-88.

BELFAST:
PRINTED BY ALEXR. MAYNE & BOYD, 2 CORPORATION STREET.
(PRINTERS TO THE QUEEN'S COLLEGE.)

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CONTENTS.

Belfast Natural History and Philosophical Society.

ESTABLISHED 1821.

SHAREHOLDERS.

1 Share	in the	Society	costs £7.
2 Shares	,,	,,	cost £14.
3 Shares	,,	,,	cost £21.

The Proprietor of 1 Share pays 10s. per annum ; the proprietor of 2 Shares pays 5s. per annum ; the proprietor of three or more Shares stands exempt from further payment.

Shareholders only are eligible for election on the Council of Management.

MEMBERS.

There are two classes, Ordinary Members, who are expected to read Papers, and Visiting Members, who, by joining under the latter title, are understood to intimate that they do not wish to read Papers. The Session for Lectures extends from November in one year till May in the succeeding one. Members, Ordinary or Visiting, pay £1 1s. per annum, due first November in each year.

Each Shareholder and Member has the right of personal attendance at all meetings of the Society, and of admitting a friend thereto ; also of access to the Museum for himself and family, with the privilege of granting admission orders for inspecting the collections to any friend not residing in Belfast.

Any further information can be obtained by application to the Secretary. It is requested that all accounts due by the Society be sent to the Treasurer.

The Museum, College Square North, is open daily from 12 till 4 o'clock. Admission for Strangers, 6d. each. The Curator is in constant attendance, and will take charge of any Donation kindly left for the Museum or Library.

Belfast Natural History and Philosophical Society.

ANNUAL REPORT, 1887.

The Annual Meeting of the Shareholders in this Society was held on June 27th, 1888, in the Museum, College Square North. Professor Letts, Ph.D., *President*, occupied the chair. Their were also present :—Professor Sinclair, Dr. John MacCormac, Messrs. W. H. Patterson, M.R.I.A. ; Thomas Workman, J.P. ; L. L. Macassey, M.I.C.E. ; R. Young, C.E. ; J. H. Greenhill, Mus. Bac. ; S. F. Milligan, M.R.I.A. ; Isaac Ward, William Gray, M.R.I.A.; William Swanston, F.G.S.; Dr. Steen, Mr. R. M. Young, B.A., *Hon. Secretary ;* Mr. John Brown, *Hon. Treasurer* ; &c.

The notice convening the meeting having been read, the Hon. Secretary submitted the Annual Report of the Council, which was as follows :—

"The Council of the Belfast Natural History and Philosophical Society, appointed by the Shareholders at their Annual Meeting on June 17th, 1887, desire to submit their Report of the working of the Society during the past year.

The ordinary Winter Session was opened on November 9th, 1887, with an address from your President, Professor Letts, Ph.D., the subject selected being 'Pasteur's Life and Researches.' The second Meeting was held on December 6th, 1887, when Professor Everett, F.R.S., read a paper on 'Reminiscences of the International Shorthand Congress.' The third meeting was held on January 3rd, 1888, when Mr. James Dickson read

a paper on 'The Birds of Fortwilliam Park, Belfast,' and Mr. John H. Davies another entitled 'Notes on a Waterhen's Nest.' The fourth meeting was held on February 7th, 1888, when a paper was read by Dr. James A. Lindsay on 'The Alleged Decay of National Physique.' A fifth meeting was held on March 6th, 1888, when Mr. Seaton F. Milligan, M.R.I.A., gave a paper on 'The Forts of Erin, from the Firbolg to the Norman,' illustrated by a fine series of special limelight views and antiquities. The sixth meeting was held on April 10th, 1888, when Professor Fitzgerald read a paper on 'The Action of the Screw Propeller,' illustrated by diagrams, &c. Mr. J. H. H. Swiney, B.E., also gave a paper on 'The Mechanical Removal of Deposit from Water Mains,' illustrated by maps, the actual machine used, &c. A short communication relative to a recently discovered Ogham inscription in County Tyrone was also read by Mr. Seaton F. Milligan, M.R.I.A.

In addition to the ordinary meetings, your Council made arrangements to continue the special series of popular scientific lectures similar to those given for several years past. These were very well attended, both by the members of the Society (who were admitted free) and by the general public. The first of these special meetings was held on October 5th 1887, in the Y.M.C.A. Hall, Wellington Place, when Rev. J. G. Wood, M.A., F.L.S., London, gave a lecture—subject, 'Ants'; followed by a second lecture—subject, 'The Whale,' on October 6th. The third meeting was held on January 2nd, 1888, in the Ulster Minor Hall, when Dr. A. W. Hare, F.R.C.S., Edinburgh, kindly gave a lecture—subject, 'Facial Expression,' illustrated by a special series of photographic slides. The fourth meeting was held on February 9th, 1888, in the Ulster Minor Hall, when Mr. John R. Wigham, J.P., kindly gave a lecture—subject, 'Lighthouse Illuminants,' fully illustrated by models, &c. The fifth meeting was held on March 8th, 1888, when Sir Robert S. Ball, F.R.S., lectured on 'The Astronomical Theory of the Great Ice Age.' Mr. James Meneely kindly lent his fine lantern for two of these lectures.

The improved financial condition of the Society, mentioned

in last year's report, has enabled the Council to carry out the much needed improvements to the Museum, so often deferred for want of funds. Both the interior and exterior of the building have been painted and renovated, whilst new cases have been added to the Benn Room, in which all the Irish antiquities of the Society are now placed. The lower portions of the cases in the Thompson Room have been fitted with glass fronts, and the Clermont collection of Irish birds arranged therein.

The Council, considering that it would be for the advantage of the Society that their friends and the public of Belfast should have an opportunity of seeing the improved condition of the Museum, and the recent valuable donations given to them, invited the members, and a large additional number of ladies and gentlemen interested in the work and aims of the Society, to a conversazione, held on November 2nd, 1887, in the Museum. Many valuable works of art and objects of scientific interest were kindly lent by members and friends, whilst the various collections of the Society were inspected with much interest in their improved condition. A choice selection of music was rendered during the evening by the kindness of some members of the Belfast Musical Society.

A marked increase has taken place in the number of shareholders and subscribers during the past session. Although the financial condition of the Society shows a small balance due to the treasurer, as may be seen from his report, this is explained by the amount of money expended on the necessary improvements, which it was considered advisable to do in a complete manner, and so avoid a similar expenditure for many years to come.

Your Council have relet the room known as the Library to the Ulster Medical Society for one year, reserving access to the books for the members at all times. The other societies holding their meetings in the Museum continue to do so.

Your Council arranged to open the Museum on Easter Monday, Tuesday, and Wednesday at a nominal charge. With the kind assistance of some friends, including the Belfast

Naturalists' Field Club, valuable collections of works of art and objects of interest were shown, with the gratifying result that the number of visitors was very large, the receipts amounting to about £50.

The Council have been able to considerably reduce the annual fire insurances on the Museum buildings.

A list of donations to the Museum, and of the publications received during the session from various leading philosophical and scientific societies with which we are in correspondence, is printed with the present report. The donations to the Society call for more than usual notice, as they comprise the very valuable collections of Irish Birds and Mammalia formed by a former valued member, the late Lord Clermont, and presented, by the kindness of his brother, Lord Carlingford ; the fine collections of American and Australian Birds, presented by the Earl of Erne, Crom Castle ; and the extensive collection of local fossils, formed by our former president, the late Mr. James MacAdam, F.G.S., and presented by his brother, Mr. Robert MacAdam. Other valuable objects have been again given to the Museum by Captain Robert Campbell, who is an unswerving friend of the Society. The Council desire to thank the various donors for their kindness in presenting so many interestfng objects to the Museum collections.

As the honorary librarian has had the books carefully catalogued for some time, your Council would again suggest the advisability of having the catalogue printed, so as to make the books more generally available to the members and the scientific public. Your Council now retire from office, and this meeting will be asked to select fifteen members to form a new Council."

The Hon. Treasurer, in submitting the financial statement, said that they had begun the year with a balance to credit of £62 9s. 2d., and the income for the year had been £291 4s. 2d., a larger sum than in any previous year. This increase was derived principally from increased subscriptions, while the Easter receipts had also been larger than usual. Owing, however, to an expenditure of £140 on painting and other very desirable repairs and improvements in the Museum, there was now due

to the treasurer a small balance of £15 16s. which, he might say, would be quite cleared off by the increased subscriptions next year, while, if their other sources of income continued to be as favourable, they would again have a balance to credit.

The President said before the motion for the adoption of the reports was made he might be permitted a few brief remarks. Their past session had, it seemed to him, been a very successful one, while their financial position was, he thought, extremely good. It was a striking fact that their income had increased by something like one-half in the course of three years—a fact which showed that the Society was increasing in numbers, as it was in utility and importance. He had himself been especially struck by the very much larger attendances they had had during the past session at their meetings, and with the excellence and interest of the papers brought before the Society on these occasions no less than by the admirable manner in which those papers had been criticised and discussed. Most successful, too, had been their popular lectures, a complete course of which had been arranged for at considerable trouble by the Council. Every lecture was well attended, and all were interesting and instructive, some being of great practical utility, like that given by Mr. Wigham, and others of deep scientific interest, like that delivered by Sir Robert Ball. Looking back over the course, they had every reason to be satisfied with their success in this department of the Society's efforts. In connection with their lectures he might add that he hoped some day they would possess a suitable lecture-room of their own, by which means they would avoid not only the additional expense, but the loss of proper prestige which the Society sustained by having to hire a hall for the purpose. It was impossible that a lecture given in the Ulster Hall or a similar building could be identified so closely with the Society itself as it would be if delivered in their own premises. He hoped also some day to hear that their honorary secretary had been successful in getting the Gilchrist trustees to organise a course of popular lectures for the working classes. Such a course would be useful to the Society, and of great

service to the working population of the town. In conclusion, he wished to say that he considered the Society was enormously indebted to the exertions of its honorary secretary and treasurer, Messrs. R. M. Young and John Brown. Both had thrown themselves into their work most energetically, and he had had ample opportunities of seeing how earnestly they had striven for, and what a large amount of time they had devoted to, the welfare of the Society. It must be gratifying to them to see that their exertions had not been thrown away, and that the Society was never in a more sound and flourishing position than at present.

Mr. L. L. Macassey moved the adoption of the reports and statement of accounts, which he thought, with the President, indicated most clearly that the Society was in a thoroughly good condition, that it had done a considerable amount of useful work during the past year, and gave every hope that the forthcoming session would be equally, if not still more, fruitful and successful. He had the satisfaction of being present at the conversazione referred to in the report, and he thought nothing could indicate more strongly the healthy condition of the Association, the interest its members took in its working, and the appreciation it received from the public, than the number and character of the attendance on that occasion. It was, he considered, one of the happiest combinations of science and sociability imaginable, and he trusted they would have more reunions of a similar kind.

Dr. MacCormac, in seconding the motion, said it was very gratifying to know there had been an increase in the membership, and that the financial matters were satisfactory. It was equally gratifying to see upon the record so many interesting papers which had been read by men of undoubted scientific skill and position. The Chairman had, he thought, broached a very important subject with regard to the lectures and the proposal to have a lecture-room. He trusted the lectures would be continued, and that an effort would be made to make them a little more popular in character, in which case they would undoubtedly enlist a wider sympathy and interest among

the general public. The recent additions to the collection in the Museum obtained through the kindness of a number of friends were a subject of much gratification.

Mr. WILLIAM GRAY desired to give his testimony to the appreciation which the efforts of the Council during the past year had received, particularly in the popular lecture department. He trusted, notwithstanding the apparent apathy of the public with regard to these lectures, that they would be continued during the coming session. Those which had been given were principally of a kind to be widely interesting, and the vast majority of them might have been understood and enjoyed by any intelligent working man.

Mr. GREENHILL thought Mr. Gray must be under some misapprehension with regard to the alleged apathy of the public towards the lectures. They were all splendidly attended, and on almost every occasion the hall was nearly as full as it could be. Some of the lectures, it was true, were not financial successes ; but it was their object to instruct, not to make a profit, and it must be remembered that in some cases the expenses were particularly heavy. But, as far as the attendance of the public went, they had really nothing of which to complain.

The HON. TREASURER said since they began the course of popular lectures, three years ago, the whole loss to the Society incurred thereby was only £1 17s.

The CHAIRMAN—My impression certainly was that the attendance at these lectures was very satisfactory, considering all the circumstances. At Sir Robert Ball's lecture, indeed, the hall was crowded to its utmost extent.

The motion was then passed unanimously.

The HON. SECRETARY said he had received the following letter and enclosure from Sir J. P. Corry, Bart., M.P., relative to an application to the Admiralty for the loan of some specimen armour plates pierced by projectiles, for exhibition at the Museum :—

House of Commons,
20*th June*, 1888.

My Dear Sir,

You will learn from the enclosed that I have not been overlooking the request that you made to me on the 27th April last, with reference to specimens of armour plates pierced by projectiles, and am glad that the Admiralty has consented to lend them, which I believe will be one of those loans that you will never be asked to return.

Yours sincerely,

J. P. CORRY.

R. M. Young, Esq.

The enclosure was a letter from the Secretary to the Admiralty, addressed to Sir James P. Corry, as follows :—

Admiralty, S.W.

Sir,

With reference to the application from the Belfast Natural History and Philosophical Society (forwarded to you on the 27th April last) for the loan of some specimens of trial armour pierced by projectiles, I am commanded by my Lords Commissioners of the Admiralty to acquaint you that authority has been given to the Admiral Superintendent at Portsmouth to lend the specimens required on application being made to him by the society, notifying how it is desired that the plates shall be forwarded from Portsmouth. It will be understood that the cost of carriage from Portsmouth will be borne by the Society.

Your obedient servant,

EVAN M'GREGOR.

On the motion of Mr. William Gray, seconded by Dr. Steen, votes of thanks were passed to Sir James P. Corry for the trouble he had kindly taken in the matter and to the Admiralty for their grant of the loan.

The Hon. Secretary said it was proposed to place the specimens when received in the area in front of the Museum, so that the public could inspect them without charge. They would, no doubt, be interesting in a town in which shipbuilding was so extensively carried on.

The election of members of Council was then proceeded with. The ballot resulted in the re-election of the old Council, with the exception that Professor Fitzgerald was substituted for Professor Cunningham.

The President announced that several interesting papers

had been promised for the ensuing session, among those who had given promises being Dr. Meissner and Mr. Barnett, son of Dr. Milford Barnett. The Society also hoped to be favoured with a lecture by Sir William Thomson, of whom, he was sure, every Belfast man must be proud.

The proceedings then terminated.

Presentation of Dr. James Bryce's Portrait.

At the conclusion of the Annual Meeting, the company adjourned to the lower room in order to receive from Mr. R. Young, C.E. (acting on behalf of Mrs. Bryce), the gift of a very fine portrait of the late James Bryce, LL.D., F.G.S.

The President said the ceremony they were now asked to participate in was a very interesting one—namely, to receive as a gift to the Society by his widow a very excellent portrait of Dr. Bryce, one of the most active and talented members of that Society for a number of years. He (the President) thought it was of very great importance that a Society like theirs should possess as many portraits as possible of its prominent members. Portraits were always pleasant mementoes, and as time went on and the reputation of men became more mellowed—sometimes even made after death—they became imbued with deep historical interest. A gift like the present, therefore, seemed very appropriate, and would, he was sure, be welcome to all.

Mr. R. Young, in presenting the portrait, said Dr. J. Bryce was, he believed, the first to introduce the teaching of the natural sciences in ordinary school education. He had classes for botany, mineralogy, and geology at the Belfast Academy, and was in the habit of accompanying his pupils on Saturday half-holidays to join them in their search for minerals, fossils, and plants. When he went to Glasgow in 1847, and became a teacher in the High School of that great city, he continued the same course he had begun in Belfast, and the Saturday excursions of his pupils and friends under his guidance to the various localities, of which Arran was the most attractive,

became quite famous, and were the means of spreading a taste for science that had since borne good fruit. But it was mainly his connection with that Society that he would refer to. Although he was not one of the original founders, he took an active part in its work when it numbered among its active members such men as Dr. John Grattan, Dr. T. Andrews, George Hyndman, Robert Patterson, William Thompson, Edmund Getty, and Robert and James MacAdam. The last-named was, like Dr. Bryce, an enthusiastic geologist, and they cordially and loyally co-operated in carrying on geological investigations at various points of interest, such as Woodburn, Collon Glen, and Cultra. It would probably be in the recollection of most of those present that Dr. Bryce's death was the result of his lifelong devotion to that science. He was at a remote point in the Highlands—Inverfarraghy—preparing for a lecture he was to give to some of his friends from Inverness, and was overwhelmed by a debacle of large boulders, one of which he had disturbed with his hammer. On the part of Mrs. Bryce, his (Mr. Young's) sister, he had the pleasure of presenting the portrait to the Society.

Mr. Thomas Workman, in proposing that the best thanks of the Society be tendered to Mrs. Bryce for her welcome and valued gift, agreed with those present that it would be a very pleasant thing to possess portraits of their prominent members. It was men of the stamp of Mr. Bryce and Mr. Patterson who had made Belfast what it was, not only as to its commercial reputation, but with respect to its title of Northern Athens. He trusted to see many additions to the mementoes, in the way of portraits, they possessed of the eminent men connected with the Society, and in the meantime he proposed their hearty thanks to Mrs. Bryce for the admirable portrait presented to them in her name by Mr. Young.

Mr. John Brown (hon. treasurer) seconded the vote, which was unanimously accorded.

The President said they hoped some day to possess similar portraits of men like Sir Wyville Thomson, Sir William Thomson, Mr. James Thomson, Dr. Andrews, and others

who were better known as scientists in England than in Belfast, and better known on the Continent than in England.

Rev. Charles Scott, as an outsider, expressed the pleasure with which mementoes of Dr. Bryce and other eminent men of the town in the past or in the present would be regarded by the public.

The proceedings then concluded.

The Belfast Natural History and Philosophical Society, in Account with Treasurer, for the Year ending 1st May, 1888.

Dr. **Cr.**

EXPENDITURE.

		£	s.	d.
To Cash paid	Insurance Premiums	£6	12	0
,,	Printing Report	18	10	6
,,	Advertising	6	15	0
,,	Printing and Stationery	8	4	3
,,	Water Rate	2	4	7
,,	Painting Museum Building ...	68	0	0
,,	New Cases for Benn Room	20	0	0
,,	Sundry Repairs and Additions ...	14	12	3
,,	Altering Cases in Thompson Room and making all Cases on Ground floor dust-tight	36	4	3
,,	Collector's Commission ...	5	1	0
,,	Expenses at Easter	10	10	1
,,	Deficit on Popular Lecture Account	4	14	0
,,	Wm. Darragh Salary till 1st May	48	0	0
,,	S. A. Stewart Do. do.	50	0	0
,,	Rent till 1st May	25	0	0
,,	Carriage on Donations and small accounts	7	16	7
,,	Postage and other Stamps ...	6	3	7
,,	Fuel and Gas	15	5	3
		£353	13	4
To Balance	... ...	15	16	2

RECEIPTS.

		£	s.	d.
By	Balance on hand	£62	9	2
,,	Interest on Loan to York St. Spinning Co.	19	8	0
,,	Rent for Lecture-Room	10	0	0
,,	Proceeds of One Share sold	7	0	0
,,	Donations	37	1	0
,,	Subscriptions	108	8	0
,,	Do. in Arrear	3	0	0
,,	Transfer Fees	2	9	0
,,	Entrance Fees at Door till 30th April ...	14	4	3
,,	Do. do. on Easter Monday	40	15	0
,,	Do. do. do. Tuesday	6	16	6
,,	Do. do. do. Wednesday	2	7	9
,,	Contribution given Naturalists' Field Club	5	5	0
,,	Do. Ulster Amateur Photographic Society	3	13	6
,,	Do. Ulster Medical Society ...	15	0	0
,,	Balance due Treasurer	15	16	2
		£353	13	4

Examined and found correct,

SAMUEL ANDREWS,
W. H. PATTERSON, | *Auditors.*

J. BROWN, *Hon. Treasurer.*

DONATIONS TO THE MUSEUM, 1887-88.

From Lord Carlingford.

The natural history collections of the late Lord Clermont, consisting of cabinets of stuffed specimens of birds and quadrupeds, specimens preserved in spirits, prepared specimens illustrating the osteology of various animals, antlers of Irish elk, horns of Indian buffalo, &c.

From the Earl of Erne.

One case of stuffed birds from Australia, and one case of American birds.

From Robert MacAdam, Esq.

A cabinet of local fossils, mainly cretaceous, collected by the late James MacAdam, F.G.S.

From the Belfast Water Commissioners.

An ancient rowing boat made out of the trunk of an oak tree, found in Lough Mourne.

From Mrs. Bryce.

Portrait in oil of the late Dr. Jame Bryce, F.G.S.

From Mrs. Patterson, Holywood.

Portrait of the late Robert Patterson, F.R.S.

From Miss Thompson, Dublin.

Portrait of the late William Thompson, Esq.

From Captain Robert Campbell, Master of the Ship "Slieve Donard."

One stuffed specimen of the mongoose, one case of Indian butterflies, one Indian sword, one Burmese idol, one Indian religious gift.

From W. H. Patterson, Esq., M.R.I.A.

A collection of insects from Townsville, Queensland.

From Mr. Charles Bulla.

Four specimens of carboniferous fish remains, from Armagh.

From Mr. Robert J. Welch.

Six photographic views of cromlechs in Antrim and Down.

ADDITIONS TO THE LIBRARY, 1st MAY, 1887, TILL 1st MAY, 1888.

ADELAIDE.—Transactions and Proceedings of the Royal Society of South Australia, Vol. 9, 1885-86. *The Society.*

BELFAST.—Catalogue of Early Belfast Printed Books, 1887. *The Belfast Society for Promoting Knowledge.*

Benn's History of Belfast, 1823. Volume of Belfast News-Letter for 1770, and volume of News-Letter from March 1797 to March 1798. *Miss Mackey.*

Proceedings of Belfast Naturalists' Field Club. Series 2, vol. 2, part 7, 1886-7. *The Club.*

BERLIN.—Verhandlungen der Gesellschaft fur Erdkunde. Vol. 14, parts 2—10, 1887; and vol. 15, parts 1—3, 1888. *The Society.*

BOLOGNA.—Rendiconto della R. Accademia delle Scienze, 1886-7. *The Academy.*

BRESLAU.—Zeitschrift fur Entomologie, Herausgegeben vom Verein fur Schlesische Insektenkunde, 1887. *The Society.*

BRIGHTON.—Annual Report of the Brighton and Sussex Natural History Society, 1886-7. *The Society.*

BRUSSELLS.—Bulletin de la Societe Royale de Botanique de Belgique. Vol. 26, part 1, 1887.

Comptes Rendus des seances de la Societe Entomologique de Belgique. Ser. 3, nos. 86-94. *The Society.*

Annals de la Societe Royale Malacologique de Belgique. Vol. 21, 1886; and Proces-verbaux des Seances, 1887. *The Society.*

CALCUTTA.—Memoirs of the Geological Survey of India. Vol. 24, part 1.

Do. Palæntologia Indica. Ser. 10, vol. 14, part 3.

Records, vol. 20, parts 2-4, vol. 21, part 1; and Manual of the Geology of India, part 4.
The Director of the Survey.

CAMBRIDGE, U.S.A.—Bulletin of the Museum of Comparative Zoology. Vol. 13, parts 4-8, vol. 14, part 1; and Annual Report of the Curator, 1886-7. *From the Curator.*

CARDIFF.—Report and Transactions of the Cardiff Naturalists' Society. Vol. 18, 1886, and vol. 19, part 1, 1887. *The Society.*

CHERBOURG.—Memoires de la Societe Nationale des Sciences Naturelles. Vol. 25, 1887. *The Society.*

CORDOVA, S.A.—Actas dela Accademia Nacional de Ciencias de la Republica Argentina. Vol. 5, part 3, 1886; and Boletin, vol. 9, parts 1-4, 1886.
The Academy.

DUBLIN.—Proceedings of the Royal Dublin Society, N.S. Vol. 5, parts 3-6. Transactions, ser. 2, vol. 3, parts 11-13, 1886-7. *The Society.*

EDINBURGH.—Proceedings of the Royal Physical Society, Session 1886-7. *The Society.*

Proceedings and Transactions of the Botanical Society of Edinburgh. Vol. 17, part 1, 1887.
The Society.

Notes on the Ancient Iron Industry of Scotland, by W. Ivison MacAdam, F.S.A., Scot., 1887.
The Author.

ELBERFELD.—Jahres Berichte. Naturwissenschaftlichen Vereins.
The Society.

EMDEN.—Einundsiebenzigster Jahresbericht der Naturforschenden Gesellschaft, 1885-6. *The Society.*

ESSEX.—The Essex Naturalist. Nos. 5-12, 1887, and nos. 1-3, 1888. *The Field Club.*

FLORENCE.—Bullettino della Societa Entomologica Italiana Anno 19, parts 3 and 4. *The Society.*

GENOA.—Giornale della Societa de Letture. Anno 9, fasc. 10, and anno 10, fasc. 3-12. *The Society.*

GIESSEN.—Funfundzwanigster Bericht der Oberhessischen Gesellschaft fur Natur und Heilkunde, 1887. *The Society.*

GLASGOW.—Proceedings of the Natural History Society of Glasgow, n.s. Vol. 1, part 3, 1885-6.

Proceedings of the Philosophical Society of Glasgow. Vol. 18, 1886-7. *The Societies.*

GORLITZ.—Abhandlungen der Naturforschenden Gesellschaft, Neunzehnter Band, 1887. *The Society.*

HAMBURG.—Abhandlungen aus dem Gebiete der Naturwissenschaftlichen, herausgegben vom Naturwissche Verein in Hambourg, vol. 10, 1887. *The Society.*

KIEFF.—Memoirs of the Society of Naturalists of Kieff, supplement to vol. 8, 1887. *The Society.*

KOLOZVART, TRANSYLVANIA.—Maygar Novenytani Lapok (*Hungarian Journal of Botany*). Vol. 2, 1887. *The Publisher.*

LAUSANNE.—Bulletin de la Societe Vaudoise. Vol. 22, nos. 95 and 96, and vol. 23, 1887. *The Society.*

LEICESTER.—Report of British Association Committee on Provincial Museums, 1887. *From the Secretary of the Committee.*

LEIPSIC.—Mittheilungen des Vereins fur Erdkunde zu Leipzig. Part 1-3, 1886. *The Society.*

LIVERPOOL.—Rickett's The Base of the Carboniferous Rocks, 1887. *The Author.*

LONDON.—Memoirs of the Royal Astronomical Society. Vol. 49, part 1, 1888. *The Society.*

Quarterly Journal of the Geological Society. Nos. 168-174, 1886-8; and List of Fellows of the Society, 1887. *The Society.*

Journal of the Royal Microscopical Society. Parts 58-63, and Supplement to part 61, 1887-8. *The Society.*

Proceedings of the Zoological Society. Parts 1-4, 1887. *The Society.*

MANCHESTER.—Transactions of the Manchester Geological Society. Vol 19, parts 8-17, 1887-8.

MELBOURNE.—Proceedings of the Royal Society of Victoria. Vols. 22 and 23, 1886-7. *The Society.*

MEXICO.—Anuario del Observatorio Astronomico Nacional, Ano 8, 1887. *The Observatory.*

MOSCOW.—Bulletin de la Societe Imperiale des Naturalistes de Moscou. No. 3, 1886; nos. 2, 3, and 4, 1887; no. 1, 1888; and Meteorologische Beobachtungen, 1887. *The Society.*

NEW YORK.—Annals of the New York Academy of Sciences. Vol. 4, nos. 1 and 2, 1887. *The Academy.*

Bulletin of the American Geographical Society. Vol. 19, nos. 2-4, and Supplement, 1887. *The Society.*

ODESSA.—Memoirs of the Society of Naturalists of New Russia. Vol. 12, parts 1 and 2, 1887-8. *The Society.*

OTTAWA.—Geological Sections to accompany Report for 1885. *The Geological Survey of Canada.*

PADUA.—Atti della Societa Veneto-Trentine di Scienze Naturali in Padova. Vol. 2, fasc. 1, 1887. Bulletino Vol. 4, no. 1, 1887. *The Society.*

PHILADELPHIA.—Proceedings of the Academy of Natural Sciences of Philadelphia. Parts 1 and 2, 1887. *The Academy*

The Journal of Comparative Medicine and Surgery. Vol. 9, no. 1, 1887. *The Publisher.*

Transactions of the Wagner Free Institute of Science. Vol. 1, 1887. *The Institute.*

PISA.—Atti della Societa Toscano di Scienze Naturali; Processi Verbali, vol. 5, 1887, 2 parts; and 2 parts of vol. 6, 1887-8. *The Society.*

ROME.—Atti della Reale Accademia dei Lincei. Ser. 4, vol. 3, fasc. 1-13, 1887; and vol. 4, fasc. 1 and 2, 1888. *The Academy.*

SAN FRANCISCO.—Bulletin of the California Academy of Sciences. Vol. 2, nos. 6 and 7, 1887. *The Academy.*

SANTIAGO DE CHILE.—Verhandlungen des Deutschen Wissenschaftlichen Vereins zu Santiago. Part 4, 1886. *The Society.*

SIENNA.—Bollettino del Naturalista. No. 11, 1887. *The Publisher.*

STIRLING.—Transactions of the Stirling Natural History and Archæological Society, 1885-6, and 1886-7. *The Society.*

TORONTO.—Proceedings of the Canadian Institute. Vol. 22, fasc. 1, 1887. *The Institute.*

TRIESTE.—Bollettino della Societa Adriatica di Scienze Naturali. Vol. 10, 1887. *The Society.*

VENICE.—Notarisia Commentarium Phycologicum. Anno 3, nos. 9 and 10, 1888.

L'Algarium Zamardini per Docters Toni and Levi, 1888. *The City Museum.*

VIENNA.—Verhandlungen der Kaiserlich Koniglichen Geologischen Reichsanstalt. Nos. 7-18, 1887; and nos. 1-4, 1888. *The Directors.*

Verhandlungen der Kaiserlich Koniglichen Zoologisch-Botanischen Gesellschaft. Vol. 37, parts 1-4, 1887. *The Society.*

WASHINGTON.—Sixth Annual Report of the Geological Survey of the United States, 1885. *The Director.*

Smithsonian Miscellaneous Collections. Vols. 28-30, 1887.

Annual Report of the Smithsonian Institution, 1885, part 1. *The Institution.*

YORK.—Annual Report of the Yorkshire Philosophical Society, 1887. *The Society.*

ZURICH.—Vierteljahrschrift der Naturforschenden Gesellschaft. Vol. 30, parts 1-4, 1885; and vol. 31, parts 1 and 2, 1886. *The Society.*

BELFAST

NATURAL HISTORY & PHILOSOPHICAL SOCIETY,

SESSION 1887—88.

9th November, 1887.

The President, PROFESSOR E. A. LETTS, Ph.D., F.R.S.E., F.C.S., gave an Address on

PASTEUR'S LIFE AND RESEARCHES.

THE PRESIDENT said that Louis Pasteur was born on December 27th 1822, in a town in France not very far from the Swiss frontier. His father had served in the army, and on his retirement started business as a tanner. There was nothing of special importance to note in the boyhood of Pasteur. Like all young people he preferred the very healthy instinct of play to work, and it was not an unknown event for him to go a fishing when he ought to have been at school. He also appeared to have had a love for the pencil, and many of his sketches and caricatures are still to be seen. There was, in fact, one old lady who knew M. Pasteur as a boy, and who thought he quite missed his vocation in life, and that he would have done much better if he had been an artist. With increasing years, however, young Pasteur settled down to his school work, and it was at the College of Besançon that his chemical instincts first showed themselves. At the age of twenty Pasteur successfully passed the examination for entrance to the Ecole Normale. Here M. Pasteur's career as an experimenter really commenced, and he could have been ever found at this time in the midst of those researches the issue of which might be heard of in every civilised

country. His chemical teachers in Paris were Dumas and Balard, and both seem to have had their own special influence in moulding his character. The vivacity of Balard and his enthusiam on the one hand, and the serene gravity, exactness, and method of Dumas on the other, both answered the needs of Pasteur's mind, so that the teachings of both were to be clearly traced in Pasteur's researches. It is certain that this great man owed to the freedom of work and the facilities for solitary reading which he then enjoyed the first occasion for an investigation which was the starting point to a discovery. Pasteur's career as a scientific discoverer was a very remarkable one. Glancing over his different researches it might almost be thought at first sight that they dealt with a wide range of subjects utterly unconnected with each other; yet they were really all more or less mutually dependent. And that this was the case is more remarkable, as is shown by the fact that again and again chance circumstances led him from subject to subject. Whatever work came in his way he threw himself into with the ardour of an enthusiast. Nothing daunted him. Nothing could stay his progress. He has, as Tyndall so well put it, that almost Divine power of "distilling from facts their essence." His scientific genius is almost irresistible, and difficulties fall before him like corn before the reaper. Pasteur's life has been largely devoted to the study of what had been called, not unaptly, "the infinitely little"—that world of tiny organisations invisible to the naked eye, but so marvellously potent, sometimes for good and at others for evil. It is M. Pasteur who has shown that everywhere surrounding us this invisible and unsuspected host lurk, some, it may be said, friendly and ready to labour for us if we command them; others deadly enemies, biding time and opportunity to attack, and even to slay us. Others, again, silently engage in those great works of nature by which the earth is constantly purified, and all traces of death and decay obliterated. And not only has M. Pasteur traced the workings of this liliputian army, but he has gone a great deal further, and has, it may almost be said, brought it into subjection, for he has taught

how in certain cases the attacks of the inimical organisms may be repelled, and how we may make those which are usefully disposed do work for us in the most efficient manner. If he was asked how Pasteur had discovered these new fields of scientific investigation he would answer that he was the first to make the microscope an instrument of chemical investigation, and in so doing he has rendered as much service to science as did his great countryman when he introduced the balance into chemistry. The President then went on to deal with the experiments of Pasteur in relation to rock-crystal, with special reference to the discoveries of Biot and Arago—namely that a species of crystal cut in a certain direction possesses the power of turning the plane of a ray of polarised light. Mention was also made of the appointment of Pasteur to the assistant professorship of chemistry at Strasburg, where he threw all his powers and energies into his researches. Shortly after his appointment he became engaged to the daughter of the rector of the University, and in speaking of this event M. Radot poked a piece of fun at M. Pasteur, who is his father-in-law. He said :—" It is even asserted that on the very morning of his marriage it was necessary to go to his laboratory and remind him of the event which was to take place that day." " But if," he continued, " Pasteur was thus guilty of an absentmindedness worthy of La Fontaine, he proved as a husband so different from La Fontaine, that Madame Pasteur when reminded of this lapse of memory receives the reminder with an indulgent smile."

The lecturer then spoke of M. Pasteur's experiments in fermentation, and stated that the great French chemist's operations were such as overthrew other theories of fermentation, and were marked by elegance, simplicity, and exclusiveness. The experiments of Pasteur during the terrible and disastrous silkworm epidemic, the beneficial results which he achieved in this as in other branches of medical science, were also fully dealt with.

He had still to tell his audience of one other investigation in which Pasteur has been engaged. They probably guessed

at the nature of that investigation, for it had attracted a great deal of public attention, and it might have been brought specially to their notice by a recent occurrence in this town. He meant hydrophobia—that fearful malady to which dogs especially, and occasionally cats and wolves, are prone. All know that a rabid dog or cat is as dangerous, if not more so, as the most venomous snake; that its bite means in all probability death, and death aggravated by the most frightful sufferings. Here is a picture of a case :—On December 10th, 1880, a child, five years old, who had been bitten in the face a month previously, was dying in the Trosseau Hospital. Devoured at the time by a raging thirst, and seized with a horror for all liquids, he approached with his lips the spout of a closed coffee-pot, then suddenly started back, the throat contracted—a prey to such fury that he insulted the nursing sister who was attending on him. He was at the same attacked by aerophobia to a prodigious degree. At a certain moment the heel of one of his feet protruded from the bed. An assistant blew upon it. The child had not seen the assistant, and the breath of air was so light as to be almost imperceptible. The poor child flew into a rage, aud a violent spasm seized him in the throat. The next day delirium began—a fearful delirium; the frothy matters which filled his throat suffocated him. M Radot told them that Pasteur was specially attracted to this disease by the great reserve, if not opposition, shown to his ideas by many medical men. He wished to prove conclusively that hydrophobia was as much due to organisms as spleen fever, and no doubt he was equally animated with a benign desire to discover some method for preventing or, at all events, checking its ravages.

In 1880, Pasteur commenced his investigations on hydrophobia, and in June of the present year a Royal Commission appointed by the English Local Government Board to inquire into M. Pasteur's researches issued its report. He would not attempt to follow the course of the investigation, which was enshrouded in unusual difficulties. For instance, a difficulty arose at the outset in proving that a micro-organism was really

the cause of the disease, and here a very curious complication arose. The case of the poor child who died of hydrophobia in the Trousseau Hospital, whose sufferings M. Radot so graphically described, was, he believed, the first brought under the notice of M. Pasteur. Four hours after the child's death the mucus from its palate was collected and experimented upon by Pasteur. It was diluted with water, and two rabbits were inoculated with it. Thirty-six hours later the rabbits died, and the saliva of these dead rabbits proved fatal to other rabbits. In their blood was found a micro-organism which could only be cultivated outside their bodies in an artificial nourishing medium, and when inoculations were made with these artificial cultures into the bodies of rabbits the latter soon died. Here, then, was apparently the complete chain of proof as to the nature of hydrophobia ; but one important link was deficient—the period of incubation. The rabbits died thirty-six hours after inoculation, whilst genuine hydrophobia does not show itself until several weeks after the bite of a rabid animal. How could these curious facts be accounted for ? Pasteur soon found that the micro-organism was not alone present in the saliva of the child dead of hydrophobia, but also occurred in that of children dead from other diseases ; and, extending these researches, he actually found the same organism in the saliva of a number of healthy people. Here was a terrible revelation, repulsive to their feelings as regarded the dignity of the human race, and humiliating to their *amour propre*, for it was not a pleasant thing to reflect that we resemble rattlesnakes.

But to return to hydrophobia. It is evident that it is not caused by this micro-organism ; and he was not aware that up to the present time the actual organism has been obtained and cultivated outside the body in an artificial medium. But it is certain that the disease closely resembles all those which have been proved to be due to organisms, and Pasteur has been guided by these analogies in his researches. He now came to the reliable and unbiassed opinion of the English Royal Commission. The essence of their report was as follows :—

Pasteur believes that the virus of rabies is a living micro-

organism, and that, like many others, it produces in the tissues which it invades, a substance whereby, when present in sufficient quantity, its own development and increase are checked, just as the yeast plant ceases to grow in a saccharine liquid when the alcohol which it produces out of the sugar reaches a certain strength. In accordance with this theory, he thinks that the spinal cords of animals that have died of rabies contain both the virus and the antidote (or excretory substance), and his researches have taught him that by drying the cord in a pure atmosphere at twenty degrees centigrade the potency of the virus is diminished, whilst that of the antidote is not proportionately lessened. His method of treatment consists in hypodermically injecting carefully sterilised broth in which the spinal cords of rabbits dead of hydrophobia have been crushed and diffused. The first injection is made with a spinal cord of an animal dried for fourteen days after its death ; the second (on the next day) with a spinal cord dried for thirteen days ; the third (on the next day) with a spinal cord dried for twelve days, and so on to the tenth day of injection—that is to say with a progressive decrease in the time of drying the spinal cord. In certain cases, when severe bites had been received, or where a long period had intervened between the bite and the treatment, Pasteur increased the intensity of the latter by successively injecting on the first day what in his milder treatment he took three days for, so that on the seventh day he inoculated the patient with a spinal cord dried only for one day, and this treatment was often repeated ; but he has now rather lessened the severity of the treatment.

Now, how has this method succeeded? Between October 1885 and the end of Deeember 1886 Pasteur inoculated 2,682 persons. Carefully collected statistics have shown at the very lowest estimate five persons in every hundred bitten by rabid animals die. Therefore, if 2,682 persons had not been treated, at least 130 should have died. But up to the time of issuing the report only 33 had succumbed, and of these seven were bitten by rabid wolves, in three of whom hydrophobic symptoms appeared while under treatment. Including these, then, 97

lives had been saved by the treatment; excluding them, 104.

That was the result of the Royal Commission's inquiries. But was it possible to protect animals from that fearful disease? Here the question was much simpler and more easily decided than in the case of human beings, and the Royal Commissioners were themselves enabled to submit it to an experimental inquiry. Mr. Victor Hersley, the secretary to the Commission, was entrusted with the experiments. Through the kindness of Pasteur, two rabbits inoculated by him were placed at the disposal of the committee, and were conveyed safely to the Brown Institution within twenty-four hours. A week later they showed the first symptoms of hydrophobia, and eventually died. Other rabbits and dogs were then inoculated with the fresh spinal marrow of the dead rabbits, and died, with all the symptoms of hydrophobia. The disease was thus proved to be capable of rapid transmission in the manner described by Pasteur. Next the preventive treatment was tried. Six dogs were protected by Pasteur's method of treatment, and were allowed to be bitten by furiously rabid animals; at the same time unprotected dogs were also allowed to be bitten. Only one protected dog died, and he perished, not from hydrophobia, but from other causes. Inoculation from his spinal cord did not produce hydrophobia. Of the unprotected animals, all the dogs died, and from 50 to 75 per cent. of the rabbits. Thus, all the experiments performed by Mr. Horsley had confirmed M. Pasteur's discovery of a method by which animals might be protected from rabies, and the Royal Commission further state that they think it certain that M. Pasteur's treatment of those who had been bitten by rabid animals has prevented the occurrence of hydrophobia in a large proportion of those who would otherwise have died of the disease; "and we believe," they say, "that the value of his discovery will be found much greater than can be estimated from its present utility, for it shows that it may be possible to avert by inoculation, even after infection, other diseases besides hydrophobia."

Let us hope that Pasteur may long be spared, and that he may realise, in part at least, the fulfilment of that conception.

Science, humanity, and our dumb companions, will for ever be his debtors. As it was, his name has been rendered immortal by his beautiful and wonderful discoveries.

Mr. J. J. MURPHY said he was sure he expressed the feelings of all present when he said that they had listened to the address of their President with delight. He did not believe they had ever heard an address which was more interesting.

Professor LETTS thanked them for their kind indulgence. There was one thing he did not mention. Several people had asked him about M'Govern. He had not the pleasure of his acquaintance, and he knew nothing of him ; but a great many people seemed to think he had been successful. He did not know how that was ; but he knew the Royal Commission, which had issued the report, stated that all drugs they had tried had been of no service whatever. Let them look at the question. Let them estimate the deaths at five per cent. of those bitten. Now, suppose M'Govern treated one hundred, if he only lost five patients, everyone would say that he had cured ninety-five, and he would get an immense reputation. He did not like to speak about a method he was unacquainted with ; but it did occur to him that the supposed cures might be owing to the fact that he might have been dealing with cases in which the disease would not have proved fatal.

7th December, 1887.

Professor E. A. Letts, Esq., Ph.D., F.R.S.E., F.C.S., in the Chair.

Professor Everett read a Paper on

REMINISCENCES OF THE INTERNATIONAL SHORTHAND CONGRESS.

Professor Everett began his lecture by a brief review of the history of English shorthand, mentioning in particular the names of Bright, John Willis, Cartwright and Rich, Mason and Gurney, Byrom, Taylor, and Pitman, and giving some account of their systems. The earlier French systems were to a large extent based on Taylor, but the modern tendency of French shorthand is best seen in the system of Duployé. The German systems are conducted on an entirely different plan, their alphabets being formed by selecting the elements of the letters of German longhand, and not by the employment of simple geometrical forms, as with us.

The German and French systems were well represented at the Congress, both by the presence of delegates and by the prominent display of specimens in the room set apart for the purposes of an exhibition. There was a very full attendance of London stenographers, and a small representation from each of the principal towns in England and Scotland, but there was scarcely anyone from Ireland. The Congress was well managed, and its debates, though conducted with much spirit, were without acrimony. The two leading men were Mr. Thomas

Allen Reed, who was Chairman of the Phonographic Jubilee Committee, and Mr. Gurney Salter, official reporter to the Houses of Parliament, who was Chairman of the Tercentenary and General Committee. Both of them were excellent men of business and good speakers, Mr. Salter being about the best speaker at the Congress, while Mr. Reed was reputed to be the most skilful shorthand writer in the world.

One of the earliest subjects of discussion was Parliamentary reporting, as at present conducted in different countries. A list of printed questions relating to it had been circulated by the General Committee, and had brought full replies from all parts of Europe, as well as from the United States and the British Colonies. In nearly every country but England the shorthand writers have places assigned them in the centre of the House, so as to give them the best possible facilities for hearing. In several countries, including the United States, there is a verbatim official report; and in the European countries, as a rule, the notes for this purpose are taken in duplicate by two men, who serve as a check on one another. In the gallery of our House of Commons the hearing is moderately good, but in the gallery of the House of Lords it is intolerably bad. The evidence given before Parliamentary committees was taken verbatim by a shorthand writer from Gurney's office, who sat at a table in the best position for hearing. The same writer kept his place during the whole of one sitting, and leaves from his notebook were fetched away every half hour to Gurney's office, where they were read aloud by another man to a longhand clerk, or rather to two clerks at once, and the transcript thus produced was afterwards read over to the shorthand writer, who followed it in his original notes and pointed out any errors that had been made. The evidence was in the hands of the committee in print the next morning. As several committees might be sitting simultaneously, a large staff was necessary. Most of the writers used Gurney's system of shorthand, but a few used Pitman's or Taylor's.

In the English law courts verbatim notes are taken on behalf of the suitors, but there are no official shorthand

writers except in the Divorce Court. This subject was touched upon by Sir Charles Russell in his speeches at the opening meeting, and at the dinner he expressed a strong opinion that the whole proceedings should be taken down by an official reporter, so as to dispense with the present tedious process of note-taking by the judge. This was also the general, but not the unanimous, opinion of the speakers at the conference.

A broad line is drawn in London between newspaper reporters and another class of men who are called "shorthand writers." The business of the latter is to take a completely verbatim note, especially in the London law courts, where their employment lies. As no abridgment is permitted, they require to be able to write at a very high speed, and they must also have five years' practice before they can be admitted members of the Institute of Shorthand Writers. When taking down evidence given before committees, as in the case of Gurney's men, they must be able at any moment to read off from their notes any part of the evidence respecting which a dispute may have arisen. This great skill is only acquired by long practice, combined with a very elaborate system of abbreviation, and resting on a foundation of great natural dexterity in rapid penmanship. No thought is given at the time of writing, except in the case of unusual words, either to sound or spelling, but the outline for each word is individually known and written by memory. Such methods of writing are not adapted to the wants of people who merely wish to use shorthand as an aid in their ordinary business ; neither are they adapted to school work, and it does not appear that there was any school in the whole of the United Kingdom where shorthand is used to save time in the writing of English exercises, with the single exception of one of the Board schools of Leeds, where his (Professor Everett's) own system is regularly used for that purpose by the boys in the higher classes, and by the pupil teachers, whereby a very great saving of time is effected.

The members of the Congress were hospitably entertained by the Lord Mayor at a luncheon in the Mansion House, and

were specially shown over both houses of Parliament under the guidance of Mr. Gurney Salter. Special interest centred in the Wednesday evening meeting, for the purpose of presenting Mr. Isaac Pitman with his bust. Writers of all systems, from all parts of the world, were there to testify their veneration for the man who had been the leading figure in modern shorthand history, and who had also taken the leading part in labouring for the reform of English spelling. The German members of the Congress spoke very strongly on this last point, and testified that the schoolmasters of their country preferred to teach French rather than English, because when they see a French word they can tell how it ought to be pronounced, whereas when they see an English word it is impossible for them to tell. Mr. Gurney Salter caused some amusement by stating that he had in his possession written communications, which he had received from three different Lord Chancellors, which showed that with all their learning and accuracy these noble lords were bad spellers.

The results of the Congress had been so satisfactory that it was unanimously agreed to continue it in future years. The next Congress is to be held two years hence at Munich, in connection with the unveiling of a monument to Gabelsberger, the father of German shorthand. The proceedings of the Congress were taken down for the committee by skilled shorthand writers, and are being printed in full at a comparatively small price.

Professor Everett concluded by giving a most interesting illustration on the blackboard of the system of shorthand at present in use, pointing out the high state of proficiency attained by several phonographers throughout the world in the several systems they practised. He also referred to the efforts which are being made to reform the present mode of spelling, and for his part felt that some trenchant change would be made before long. He could not help saying that the present irregularities of spelling keep back children in their schools to a very material extent, and that a reform is very much needed.

The CHAIRMAN said that he had listened to the lecture with peculiar interest, as he had become acquainted with wonders in connection with the art of shorthand he never dreamt of before. He could bear evidence, however, to the practical utility of shorthand outside of the newspaper office, where its immense value cannot be disputed. In private and commercial life it has become a great factor, and is used with the utmost advantage by thousands of people throughout the world.

4th January, 1888.

R L. Patterson, Esq., J.P., F.L.S., in the Chair.

Mr. James Dickson read a Paper on

THE BIRDS OF FORTWILLIAM PARK.

Mr. Dickson's paper dealt with the characteristics and habits of the birds frequenting Fortwilliam Park, a suburb of Belfast, covering an area of 150 acres. These include the kestrel, sparrow-hawk, missel-thrush, song-thrush, redwing, fieldfare, blackbird, robin, stonechat, grasshopper warbler, sedge-warbler, garden-warbler, whitethroat, willow wren, chiff-chaff, goldcrest, great-tit, blue-tit, coal-tit, hedge-sparrow, wren, common creeper, rook, jackdaw, magpie, starling, bullfinch, house-sparrow, greenfinch, chaffinch, linnet, twite, lesser redpole, reed-bunting, yellow-hammer, swallow, house-martin, sand-martin, pied wagtail, grey wagtail, meadow pipit, skylark, common swift, king-fisher, cuckoo, ringdove, pheasant, heron, corncrake, waterhen, lapwing, curlew, redshank, woodcock, snipe, jacksnipe, wild-duck, and black-headed gull.

Referring to the kestrel, which nests regularly in the rocky cliffs of the Cave Hill, and occasionally pays the Park a visit, he said it is not generally known that this is a migratory bird. It leaves us in autumn to join the great flock of hawks which "stretch their wings toward the south." In this country it feeds chiefly on mice and beetles, though the few kestrels that remain with us throughout the winter no doubt largely subsist on small birds. It is found during our winter months in swarms

in Africa, and in districts where the locust abounds, it feeds almost exclusively on that insect.

The song-thrush is also to a great extent migratory. On the arrival of winter these birds collect in small companies and leave us for Palestine and Algeria, returning about the end of February, though a few remain in the shrubberies throughout the year.

The red-wing, a winter visitant, which comes to us about the time the song-thrush leaves, is often mistaken for it. The song of the red-wing, which has earned for that bird the title of "Swedish Nightingale," is often heard in the Park about the beginning of April.

A curious fact in the migratory movements of the field-fare, another winter visitant, was recorded in the last "Migration Report." At Rathlin O'Birne island between the 18th and 23rd December, 1885, immense flocks of field-fares, accompanied by starlings and song-thrushes, were seen by the light-house keeper flying to the west. The nearest land to the west of that island is America.

The robin presents a striking instance of the variability of the migratory instinct. Although resident in the British Islands, as a species it is largely migratory. They have been seen passing over the island of Heligoland in flocks during September. The robin is the earliest warbler to reach Sweden. As a songster the robin is said to be "of the royal line of the nightingale."

The grasshopper warbler, a regular summer migrant, though a rare visitor, nested last year in the Park. The intelligence of the whole warbler tribe is said to be remarkable. Two of the continental warblers in some districts invariably work a piece of snake's slough into the structure of their nests—a notice, it is supposed, to marauding lizards to beware of snakes; and fish-scales have been found in some of the nests. The song of the grasshopper warbler is said to be so like that of the large grasshopper as scarcely to be distinguished from it, and in countries where those insects are found the bird is supposed to use its note to lure them.

The sedge-warbler sings regularly during the season for several years, often so late as ten o'clock at night. Heard in snatches at that hour, and at some distance from the listener, it might suggest the nightingale ; but he (Mr. Dickson) was of opinion that the full songs of the two birds do not at all resemble each other.

The garden-warbler, which is an irregular visitor to the Park, is said to be rarely seen in the same district with the black-cap warbler. The garden-warbler is somewhat common on the banks of the Lagan, and it would be interesting to know if the blackcap is also to be found there.

The willow wren is very abundant. That charming little migrant, weighing under three drachms, comes all the way from the forests of Algeria, 1500 miles off. The golden-crested wren, smallest and most elegant of British birds, and a resident in the Park, is to a great extent migratory. Large arrivals take place every year from Norway and Sweden. They stop for a day or so at that favorite bird-hostel, Heligoland, on their way across, and arrive regularly a few days before the woodcock.

In connection with the tradition that the magpie was first found in Ireland in the County of Wexford 300 years ago, having been brought over by the English, he stated that continued observation has shown that migrants to Ireland enter the country in immensely large numbers near the Tuskar Rock, Wexford, and that route is undoubtedly the great highway for birds coming across England to Ireland during their autumnal movements.

Some striking instances were given of adaptation to surrounding colors by the chaffinch in the construction of its exquisite nest. One bird which built its nest in an Austrian pine within arm's length of the public road through the Park, so skilfully intertwined little pieces of white paper into the structure—obviously to mimic the white buds of the pine—that it escaped detection. The separation of the sexes for a time during winter has often been remarked in Fortwilliam Park and district. The chaffinch possesses rare vocal powers. It has

been heard to repeat its song 300 times in an hour.

The skylark used to nest regularly in the Park, but has now ceased to do so. The autumnal movements of that bird are very interesting, chiefly from the enormous numbers sometimes seen. Night and day for several days together armies of larks pass inland into England. Mr. Seebohm found himself one night on Heligoland surrounded by a "drifting sea" of these birds ; clouds of them, he said, emerged in an unbroken stream from the darkness, and during the two hours he watched, the "rush" went steadily on.

The swifts' power of flight is simply marvellous. It has been known to remain on the wing for sixteen hours at a stretch, and its estimated rate of flight is 270 miles an hour, a speed which if maintained would take it from London to New York in eight hours ; so that from Madrid to London, a distance of 780 miles, would be only a pleasant little evening excursion. It is not thought, however, that the bird comes straight to us from its winter quarters. It has a habit of "lingering by the way," and swifts on migration sweeping one day over the olive gardens of Spain are probably found a week later circling round the oaks of Old England.

The cuckoo's curious habit of depositing its eggs in the nests of other birds was dwelt upon at length. It lays five eggs in the season, at intervals of seven or eight days. The cuckoo cannot rear its own young. Young cuckoos are such gluttons it would be impossible for any mother to find sufficient food for five of them. The male cuckoo is also exceedingly voracious, and entirely occupied in feeding himself. Again, the young birds in the same nest would be of widely different ages, which would lead to still further complications ; so the cuckoo cuts the Gordian knot. It places its eggs, one in each, in the nest of some insectivorous bird, mostly the meadow-pipit. The cuckoo presents an interesting case of protective mimicry. It is one of the most defenceless of birds, being of very weak structure, and its resemblance to a hawk no doubt protects it from attack.

The wood-pigeon has no alarm note, and Mr. Dickson had

observed that although the bird can fly from its nest almost as quietly as an owl, it rises with great noise of wing from the tree near its feeding ground when disturbed. Does the wood-pigeon use its wings as danger-signals? He had once observed the pheasant, when under the point of a dog, hide its head among the withered leaves, as the ostrich is fabled to do in the sand.

The corncrake, a summer migrant as regular in its arrival and departure as the swallow, winters in immense numbers in Palestine and in that great bird paradise Asia Minor, and most probably from those countries Great Britain and Ireland are so plentifully supplied. Though seldom seen on the wing, the corncrake possesses great powers of flight. They have been seen 200 miles out at sea, and one is recorded as having been found in the Bermudas, 500 miles from the nearest coast. About the end of September they collect in large numbers near the sea-coast in the south of England, and quietly take their departure for their winter quarters. The woodcock breeds in small numbers throughout the British Islands; but its great nesting home is Norway and Sweden, and its chief winter quarters the basin of the Mediterranean. It passes through the British isles on its way south during October and November, and many birds remain with us during the winter, leaving us again in March. The woodcock has great powers of flight, and has been estimated to travel at the rate of 150 miles an hour.

Mr. Dickson referred in detail to the habits of the various other birds frequenting and visiting the Park, preserved specimens of which from the Museum were exhibited. He hoped that many finished pictures of bird-life in other districts would follow these rough sketches of the birds of Fortwilliam Park.

Afterwards Mr. John H. Davies read the following

NOTES ON A WATERHEN'S NEST.

The brief remarks which I have to offer on some circumstances attending the nest of a waterhen (*Galinula chlorapus*) that came under my own observation, and which I jotted down at the time, were shown to my friend Mr. John Brown, who, considering that they were of some local interest, expressed a desire that they should be recorded, and it is in compliance with his request that I now read them.

The nest was first noticed on the 6th of June, in a fir tree on the bank of the Lagan, at Glenmore, near Lisburn. It contained seven eggs, and was built almost at the end of a branch, about five feet from the trunk, and fully seven feet above the usual level of the water, over which the branch extended. I have seen the nest of this bird in various queer positions, on a branch of a sycamore resting on the ground, and under a bramble bush, some thirty feet or more from the water, but never before had I seen one so peculiarly situated as this. It is known that where there is any likelihood of the water rising and causing injury to the nest the instinctive forethought of these birds is generally equal to the occasion; but that such a situation in this instance was chosen is the more remarkable, as under no circumstances has the water been known to rise higher than five feet from the branch on which the nest was placed, and there is an island close by that is never flooded. Since making note of this, I find that Mr. Morris, in his "Nests and Eggs of British Birds," quotes a writer in the "Magazine of Natural History" as making mention of a nest placed in a fir tree twenty feet above the water, and who adds, "There was a reason for it. The rising of the water in the pond frequently flooded the banks of the island, and, as I had before noticed, had destroyed several broods."

Passing the nest nearly every day in my evening walks, I had good opportunities of observing it. On the 21st I frightened off the parent bird by incautiously approaching too near,

when four newly-hatched chicks fluttered and fell into the water, their fall being broken by the leaves of a rhododendron growing under the tree. On examining the nest I found four eggs remaining, suggesting the notion that since the seven eggs were first counted on the 6th another must have been deposited ; but, only fifteen days having elapsed and incubation continuing three weeks, this supposition had to be discarded, as at the least improbable. I visited it again on the 22nd, when another young bird took the water. On the next day I found the parent sitting, and passed on without disturbing it. I next visited it on the 24th, when one of the old birds flew from under the bushes, which were too dense to allow of my seeing whether it was tending the young brood that had taken the water. Looking into the nest, another young bird tumbled out, and there were then two eggs remaining. On the following day, the 25th, another chick was out of the shell. This showed no disposition to leave the nest, as the others had done. I placed it for a momeut in the water, in which it seemed perfectly at home, and then replaced it in the nest. Next day, the 26th, it took the water in the same manner as the rest of the brood. Looking in the nest again, on the 27th, I found the remaining egg quite cold. This I broke, and, to my surprise, found it to contain two perfectly formed and all but fully developed dead birds, and there can be no reasonable doubt that both would have been hatched had not the nest been forsaken, probably owing to the parent bird having been disturbed by some men who were mowing the grass about the tree. Until this freak of nature was discovered the supposition might have been entertained that another egg had been laid in the nest after it was first noticed, in order to account for seven chicks having been hatched ; but the most likely solution now appeared to be that two other birds had been hatched from one egg.

There are three points in regard to this that might be considered noteworthy —First, the unusual position of the nest ; second, the time (five days) that elapsed from the hatching of the first four eggs to that of the sixth ; and third, that one, if not two, of the seven eggs produced two chicks each.

7th February, 1888.

PROFESSOR E. A. LETTS, PH.D., F.R.S.E., F.C.S., in the Chair

Dr. J. A. LINDSAY gave a Lecture on

THE ALLEGED DECAY OF NATIONAL PHYSIQUE.

THE past year has witnessed the revival of an ancient controversy. Amidst the rejoicings of the Royal Jubilee and the general indulgence in complacent anticipations of future advance, the voice of Cassandra has not been wanting. We have been entreated to be warned in time that a subtle danger threatens the commonwealth in its tenderest point, and that the amazing material prosperity of the age is being purchased at the ruinous cost of a fatal declension in physical vigour. The alarm was first sounded at the meeting of the British Medical Association in Dublin last August, by Sir Thomas Crawford, Director General of the Army Medical Department, who found ground for serious uneasiness in the high percentage of rejections among the recruits at present offering themselves for the army. His views received endorsement at the meeting of the British Association at Manchester, on which occasion a paper was read by Dr. Milner Fothergill on "The Effects of Town Life upon the Human Body," and in which he argued that we are rapidly becoming a nation of town-dwellers, and that town life is in the end fatal to robustness of physique.

The question may well engage our most earnest attention, as physical fitness, soundness of limb, heart, and brain, is in the ultimate issue the only permanent charter of a nation's greatness. It is true the progress of civilisation has done

much to exalt mind above muscle, but not the less is it certain that no nation can long flourish unless it preserves a normal soundness and integrity of physique. In vain have they reached such a stage of perfection, if the life of the nation is beginning to wither under an insidious blight. Such a conclusion, however, is in itself so startling, so pregnant with far-reaching issues, and so opposed to common observation and experience, that for its acceptance the most precise and convincing evidence would be required. He would endeavour to show that no such evidence is forthcoming, while at the same time they would be compelled to own that our modern civilisation has its dangers, against which it behoves us to be on our guard.

Sir Thomas Crawford had found that in the years 1860-64 inclusive, the number of rejections for physical unfitness was 371·67 per 1,000, while during the years 1882-86 the number had risen to 415·58. Sir Thomas held that the inference from this was that the lower classes, from whom the recruits for the army are chiefly taken, were of inferior physique to what they were twenty-five years ago, and that townbred populations gave by far the larger number of rejections. Before, however, we can accept these statements we must be satisfied that the conditions of the service have undergone no radical change during the interval, and that there is no reason to suspect that the recruits of the two periods may have been drawn from different classes, with different health averages. If we applied this test he believed it is hardly too much to say that Sir Thomas Crawford's argument loses nearly all its apparent force. The last twenty years have witnessed a reform in the army, and especially the institution of the short service system, which has attracted a much younger class of men to the military service than those who formerly applied for admission. The higher percentage of rejections for the army is far more probably explained on the supposition that a younger class of men now applied for admission than formerly, than by any hypothesis of a decline in national physique.

Dr. Lindsay showed that the rejections are mainly for inadequate chest development, insufficient height and weight,

all easily explained as the result of youth rather than disease. This conclusion becomes irresistible when we interrogated Sir Thomas Crawford's figures regarding the relative ratio of rejections for diseases which beyond yea or nay indicate constitutional defect. The rejections from scrofula at the earlier period were 10·54 per 1,000, while at the latter they were only 3·21 per thousand. For consumption the rejections were 4·26 per 1,000 at the first period, and only 2·54 at the second. He thought we may safely conclude that, not only did Sir Thomas Crawford's figures fail to establish their author's conclusions, but might with ease be made to bear an exactly opposite construction.

Dr. Lindsay having analysed the figures and statements adduced by Dr. Fothergill, proceeded to demonstrate the following propositions :—(1.) That we are rapidly becoming a nation of town-dwellers. (2.) That town life has many and grave dangers to health. (3.) That hygiene, preventive medicine, philanthropy, and legislation are very largely occupied in attempting to grapple with and obviate those dangers. (4.) That, when a balance is struck between the dangers of advancing civilisation and the safeguards which it is ever learning better to devise, there is no reason to apprehend a speedy degeneracy of the race.

The many and grave dangers associated with town life might be roughly classified as follows :—Dangers arising from impurity of air and water, improper dietary, lack of opportunity for wholesome exercise and recreation ; facilities which exist for the spread of communicable diseases ; and, lastly, the dangers which beset the town dwellers from the evils of excessive competition with its corollaries, and over-pressure education among the young, and feverish excitement and strain at all ages. This is the cause of a great controversy in every civilised country. Education has made almost incredible strides during the last two or three decades. It has become more thorough, rational, and scientific. We recognise, in theory at least, that the true end of education is not the acquisition of facts, but the training of faculty. With this

higher conception of education and increased attention to its demands has arisen a new danger. Intellectual cultivation may be pursued at the expense of physical strength, and the pressure of school and college competition might induce a neglect of those physical exercises and manly sports which to the growing child and youth are not less vitally essential than the training of the mind. Real danger lurks in the portentous development of the modern system of examinations. The child undergoes a monthly examination, to which are soon added the severer tests of the Intermediate Board, and thence until he graduates in the university at the age of 21 or 22 he lives mainly to be examined.

This is the fire through which most of the youths who gave evidence of intellectual promise have to pass, and it is not surprising that some of the most brilliant drop into premature graves, and that others survive with permanent injury to health. Herbert Spencer says : "Nature is a strict accountant, and if you demand of her in one direction more than she is prepared to lay out, she balances the account by making a deduction elsewhere." A report recently issued by the Austrian Minister of Public Instruction shows that the education of the middle classes there is chargeable with over-pressure and all its attendant evils. In England the question has become the sport of angry controversy, so that it is difficult to guage the precise extent of the evil ; but there is little evidence to show that it is sufficiently grave and widespread to constitute a genuine factor working for the decay of national physique. It is one thing to admit the existence of an evil ; it is quite another to exalt it to the dignity of a grave public danger, threatening the permanent physical integrity of the race. As he indicated the sources of evil, it must have struck his audience how the efforts of public bodies and private benefactors, of philanthropy, of hygiene, and preventive medicine were constantly and earnestly directed to their mitigation or removal.

Dr. Lindsay then reviewed the remedies suggested for these evils. We endeavour to preserve pure air for town popu-

lations by the regulation of drainage, the removal of nuisances, the suppression of noxious exhalations, the cleansing of the streets, the planting of the thoroughfares with trees, the provision of parks and breathing spaces, &c. These precautions are simply matters of life and death to town populations, and public bodies have an immense responsibility in such matters—a responsibility to which they are, for the most part laudably alive. It is gratifying to find our own Town Council showing commendable energy and foresight in providing outlets for our great and growing population.

The impurity of water is an evil which, he thought is being vigorously and most successfully grappled with. The ideal at which our public bodies aim is pure water and plenty of it ; and to modern appliances of engineering and sanitary science the question is simply one of money. Our local water supply has hitherto left something to be desired, but when the present extensive engineering works are completed we may hope that every reasonable want will be amply satisfied.

With reference to improper dietary, much remains to be done to warn town populations regarding the evil tendencies of some of their dietetic habits. The prevailing ignorance regarding food is a public danger, but it is being slowly counteracted. He alluded to the dearness and scarcity of dairy produce in large towns, but there is reason for looking for an improvement in these directions. The British farmer will, no doubt, learn in time to bow to the inexorable logic of facts, and, abandoning the hopeless contest which he at present wages in the production of wheat with the virgin soils of Michigan and Manitoba, will devote himself largely to dairy produce, of which he has at his doors the finest market in the world. The possibility of such a suggestion is proved by the enormous importation of eggs, which might be supplied by the home farmers. The second dietetic danger results from the excessive indulgence in various forms of stimulants. That is so well known, and is the *rationale* of such vigorous public efforts, that further insistance on it there was unnecessary.

He thought, therefore, we are safe in concluding that, while town populations are apt to drift into injurious dietetic habits, they are constantly tending towards a wider knowledge and a more correct practice. The danger from lack of amusement and physical exercise is being combatted with more or less success.

With reference to the dangers arising from the facilities existing in large towns for the spread of communicable disease, much has been done to mitigate them, but much remains. There ought to be compulsory notification of infectious diseases. The mere existence of such diseases is in a very large degree the measure of popular apathy or timidity. Typhus fever should be as completely unknown as the plague of the middle ages, and the virulence of typhoid would be abated by a rigid adherence to the necessary measures of sanitation. While much remains to be done, much has been accomplished. The various Public Health Acts have proved of immense service, as statistics conclusively show. According to Dr. Buchanan's report to the Privy Council, the sanitary regulations of recent years have effected a reduction in the mortality from one important disease—typhoid fever—amounting in many of our largest towns actually to from 30 to 70 per cent. Typhus fever is now unknown in many parts of England and Scotland. It is, unhappily, still endemic in Ireland—one of the many outward signs of the poverty and squalor existing in this island.

Having dealt briefly with the remedies for over-pressure, the lecturer said it is manifest that any attempt to guage the physique of the present day as compared with that of past generations is beset with the almost insuperable difficulty of finding data for anything like an exact comparison. We cannot bring the dead back to live and test their thews and sinews with those of the living. We cannot match the knights of old with the heroes of the present cricket ground or tennis court ; but if we could, he believed the moderns would give a good account of themselves. The armour of our ancestors proves that the moderns are at least equal to them in physical development, and the records of the Alpine Club,

of the men who have traversed the wilds of Africa, and of those who have carried the British flag to the verge of either pole, show that we may safely challenge comparison in courage and endurance with those of any preceding generation, and the soldiers who pierced the burning wastes of the Soudan would not seem to be degenerate descendants of the heroes of Blenheim and Waterloo.

The average duration of human life, according to Sir Spencer Wells, half a century ago was thirty years; it is now forty-nine. There is also a diminution in the number of those who were permanently sick. These facts are inconsistent with physical deterioration. He found encouragement and a hopeful outlook regarding the physical welfare of the people from the unquestionable moral advance which this century has witnessed, as shown by recent figures published by Sir Edmund Ducane. There can, he thought, be little doubt that the arduous march of humanity is not only onward but upward. The ascent is doubtless slow and toilsome, but it is continuous. Each age reads more or less intelligibly the experience of the preceding ages, and profits more or less thoroughly from the warning which this experience affords. Generations of men, not less than individuals, rise on stepping-stones of their dead selves to higher things. It would be strange to find an insidious physical decay associated with the immense diffusion of knowledge, the unprecedented development of religious and philanthropic effort, the victorious advance of science, and the distribution among all classes of so many of the comforts and luxuries of life such as we find to day. Yet such a decay, of which at present he could discern no evident signs, might too easily set in were we to forget that physical soundness was at the foundation of national as of individual prosperity, or were we ever to ignore the weighty words of Rawlinson, "The strength and glory of a nation are not in standing armies and ironclad fleets, but in the health, well-being, and contentment of the people."

The paper was then criticised.

Professor T. Sinclair, M.D., said he admired very much the

tone of Dr. Lindsay's paper, and he was glad to know that he was of opinion that the national physique was not degenerating. He was glad also that Dr. Lindsay had drawn attention to the question of communicable disease—a question that does not receive so much attention as it might. They were aware that a great many of the so-called communicable diseases are due to specific germs, or micro-organisms, and are capable of being propagated throughout the community by such agencies as air, water, clothing, and personal contact. He thought that where infectious diseases break out an early notification of the fact should be made to the proper authorities, in order that isolation might be effected and that the disease might be restricted to as small an area as possible. One important point that should not be lost sight of is the removal of filth. It is, perhaps, too much to expect that diseases would be altogether wiped out, so to speak, but that should be our object ; but in the meantime the compulsory notification of disease when it breaks out to the proper authority would be a step in the right direction. He agreed with most of the conclusions arrived at by Dr. Lindsay. He thought, in arriving at a correct opinion as to whether the national physique was degenerating or not, life insurance would be a good test, and one which could be depended upon with more safety than on statistics from the army. He thought it was quite possible for a very considerable degree of concentration of people to take place in our large towns without very materially affecting the national physique.

Brigade-Surgeon MacFarland said on the subject of recruiting he could not quite agree with their distinguished lecturer, although on most subjects he did concur with him. Dr. Lindsay treated the subject in the most exhaustive manner, and, indeed, he might say that a finer lecture he had never listened to. On the subject of recruiting Dr. Lindsay had looked at it more favourably than he would. In Belfast one thousand recruits were examined at the barracks in the year, and out of that number not more than six hundred passed—some for the army and some for the militia. He must say that

the standard of recruits was very unfavourable. Out of every five recruits brought forward they had to reject two. The height is smaller now than formerly, except during the close of the Crimean war, when the height was very low. We cannot draw any very accurate conclusions as to the deterioration of physique from the recruits, as it is certainly not the best class of men who present themselves. The best class are employed in the large towns, and, consequently, do not want employment in the army. It is generally those who had done something wrong or got into trouble that present themselves as recruits. It seemed to him that deterioration, if there is such a thing as deterioration in the national physique, is confined to the poor. In the public schools in England their boys are as fine as ever they were, but certainly the poor do suffer. Then we have to come to the cause of that, and we have to go back to their childhood to find it. Every man who has a family should provide four things—pure air, wholesome food, suitable clothing, and proper education. With regard to pure air, there is no doubt that the poorer children do not enjoy that requisite, and we cannot shut our eyes to the fact that it is the drinking habits of the present day that are the cause of it. Then with regard to tea-drinking, there is no doubt that it has the effect of deteriorating physique when made a substitute for milk. With regard to clothing, we have only to look at the children to know that they are not properly clad. Their education is also defective. It is not necessary that girls of that class of life should be taught so much literature. If they were taught cooking it would be a great benefit. There is a great ignorance of cooking amongst women of the lower class, and it would be a great matter if a standard book on cooking could be placed in their schools. With regard to the question of air, he had not one word to say about it, as the lecturer had been exhaustive on that point. There is a great deal attributed to water that had nothing to do with it. There is no doubt that the drinking habits of the present day have most injurious effects, but he agreed with the lecturer that the decay of national physique hardly existed.

Dr. Samuel Browne expressed the pleasure it afforded him to say a few words on that important subject. He must congratulate his young friend Dr. Lindsay on the very able paper he had brought before the Society. He had introduced a variety of topics which are of great value and importance to every individual in the community. It struck him forcibly that the main point that Dr. Lindsay dwelt upon regarding the deterioration of physique did not affect the matter so materially as the lecturer seemed to think. He had spoken of Sir Thomas Crawford's report. Well, that is not drawn from a sufficiently extended source to prove anything as regarded a decrease or increase of national physique. His impression was the same as Dr. Lindsay's, that there is no decrease. We have had no observations made which would warrant us in coming to a conclusion on the matter. He could speak of fifty years ago when he examined men for the Navy and Royal Marines, and he could assure them that the men of the present day were equal in physique to the men he then examined. He had often examined young men of from sixteen to eighteen years of age who measured thirty-one inches round the chest, and in a few years, with good feeding and plenty of hard work, that was increased to thirty-two and thirty-three inches round the chest. He had seen many men thirty-four inches round the chest, but they were comparatively rare. He thought the question of notifying the proper authority when disease broke out was a very important one ; but he was of opinion that the duty of doing that should be thrown on the head of the household, and not on the doctor. He hoped that would not be the last lecture they would hear from Dr. Lindsay.

Dr. Collier asserted fearlessly that the modern schoolboy did not suffer from over-pressure. He condemned the system of over-pressure, both as regards boys and girls, which was carried on for the purpose of getting the boy to win distinctions.

Mr. F. D. Ward, J.P., expressed his great admiration for the very valuable lecture which they had just listened to. It would, he was sure, produce very good results, especially amongst those who had had the privilege of hearing it. He should like

to have heard Dr. Lindsay saying something as to what he thought of the state of the physique of their cousins in America. From all accounts he had read about them he had learned that their physique was certainly deteriorating, and that if it was not for the continual flow of emigration from the United Kingdom the country would sink altogether. He thought it would be well if some of the important facts brought before them that evening were laid before the American people.

Mr. Conway Scott was of opinion that the national physique is not in the good condition that some persons seemed to imagine. There is no doubt that the physique of the wealthy people, who never know what it is to want food, is in excellent condition ; but do they form the majority of the people of three kingdoms ? He unhesitatingly said that the physique of the poorer classes is not what it ought to be nor what it might be, and that it is a degraded physique. Dr. Lindsay said we cannot recall the dead, and are therefore unable to test this matter. He thought there is no necessity for calling up the dead. We can make personal observations, and if we did that it would be quite apparent to anyone that the physique of the poorer classes is deteriorating. Let us look at our lunatic asylums, and at the half-lunatics who are not in asylums at all. Let us look at the workhouses, where there live the most wretched specimens of humanity, and at the semi-paupers that visited our dispensaries, and he thought they would agree with the opinion he had formed on the subject.

The Chairman said that, with regard to the water of Belfast, there was no doubt it would be unhesitatingly condemned by the majority of chemists. It was his decided opinion that the water of Belfast was not of as pure a quality as a town of that size had a right to demand. He concluded by expressing the thanks of the Society to Dr. Lindsay for his very admirable paper.

6th March, 1888.

Professor E. A. Letts, Ph.D., F.R.S.E., F.C.S., in the Chair.

S. F. Milligan, Esq., M.R.I.A., gave a Lecture on

THE FORTS OF ERIN FROM THE FIRBOLG TO THE NORMAN.

If the ancient annals of our country had been entirely lost, and nothing to illustrate its former civilisations left but the forts, castles, abbeys, churches, and sepulchral structures, there could from these be constructed a sort of skeleton history of its earliest inhabitants. Should we add to these, monuments, weapons, ornaments of the person, and all the varied objects of antiquarian interest stored in museums and private collections, we could clothe our skeleton—I might say with flesh and blood—and study with a tolerable degree of accuracy the social habits and customs, and other interesting details of social life of the people who once trod this land, just as the geologist who from examining the fossil remains of plants and animals found in a country can form a tolerably correct idea of its ancient flora and fauna. The labours of the ethnologist and the historian are closely blended with those of the archæologist, and modern science frequently steps in to the assistance of all. As an illustration of the latter, I will quote an instance where science proves most conclusively the accuracy of the ancient historian. In the annals of Ulster it is recorded that an eclipse of the sun took place in Erin on the 3rd day of May, in the year 664 A.D., at the tenth hour of the day. An astronomical calculation has been made of the various past eclipses visible in this country, and it has been ascertained, making allowance for

the change in the calendar, that an eclipse of the sun did actually occur on the exact day and hour mentioned in the annals. Occasional proof like this is of great value, as it could not possibly have been foreseen that the written record could have been thus tested so many centuries afterwards. In many instances the archæologist is able to confirm the accuracy of description of localities and structures which have been given by the ancient annalist in the course of his narrative. If our old monuments served no nobler purpose in the district in which they are situated, in this utilitarian age, than to direct attention to the stones best suited for building purposes, and the lesson thus learned were promptly attended to, there would not be so many melancholy examples of magnificent buildings succumbing to the effects of our moist and variable climate. The architecture of a people is indicative to a considerable extent of their progress and civilisation, and as such is worthy of the most careful study. We find in the oldest structures the element of strength and provision for security against the sudden attack of enemies made the prominent feature, thus showing the unsettled state of society at that period. As we proceed we may observe the various improvements introduced for the comfort of the occupiers ; and ultimately, when law and order reign, the castellated building gradually disappears, and the modern mansion takes its place, in which the architect's skill is directed to produce a building where light, health, and comfort are the primary considerations. The old forts and cashels should be held in affectionate remembrance by us, for in them our ancestors, both Pagan and Christian, resided up to comparatively modern times. Looking at such venerable structures from this family history point of view, should tend to increase our interest in these works of our forefathers. The duns, raths, lisses, and cashels, which have given names to hundreds of towns and townlands through the length and breadth of Erin, were erected by the labours of past generations, whose sepulchral monuments also survive to show that they were no mean builders. Inside these forts were the dwelling houses in which they lived, and I was almost going to say, died, but I think to

the latter there were numerous exceptions, as dying in one's bed in these old times was probably the exception. I shall proceed to place before you some gleanings and researches of mine concerning some of these ancient forts, together with a short sketch of some of the more important castles that have held a prominent place in the history of the country. In order more clearly to understand the subject, I shall briefly refer to the early colonisation of the country, and the people who built these forts. When the ancient laws of Ireland are fully translated and published we shall be in a position to form a clearer conception of the people, and the motives which influenced them in many of their social and national customs, as recorded in the annals.

The lecturer proceeded to recapitulate the various colonies who landed on these shores. There were three colonies before the Firbolgs, none of which succeeded. The Firbolgs made their mark in the country. They were a dark-haired race, with long-shaped head and rather small stature. Their descendants still live in the Counties of Mayo, Galway, and Kerry. The Tuatha De Danaans, who next arrived, were a Celtic race, fair-haired, with globular-shaped heads, and of large stature. The Milesians or Scots were the next to arrive, and conquered the two former. The descendants of these various tribes, together with Danes, Normans, and the settlers of the Plantation, go to form the present population of this country. The various kinds of forts were next explained. The dun was an earthen fort, with one or more concentric moats and intervening fosse filled with water ; it was of a military character, and was generally owned by a righ or king, or a chieftain of a district. The rath and lis were also earthen forts like the dun, with the exception that the fosse was not filled with water. The cahir, or cashel, was a stone rath, built of huge stones, without mortar, and had frequently ramparts of earth surrounding them as an outwork. Views, specially taken to illustrate this subject, were shown of earthen forts and cashels. Amongst these were several views of the Grianan of Aileach, near Derry, the ancient seat of the O'Neills. This structure was built more than 3,000 years ago,

and is the first cashel recorded as having been built in Erin by the Danaans. It was in a very ruinous state until in 1873, when Dr. Walter Bernard, of Londonderry, undertook the task of restoring it in accordance with the original plan. The stones used were those that had fallen from the building, and the original design was carried out in every particular. It took Dr. Bernard and those who assisted him all the spare time they had for a period of five years to complete it. It is well worthy of a visit, and a most magnificent view of Lough Swilly and also of Lough Foyle may be had from its ramparts. Reference was next made to another cashel which the lecturer visited in County Sligo, called Cashel-ore, which he showed photos of and described. This cashel is referred to in the "Annals of the Four Masters" in the year 1389, when O'Rorke, of Breffny, invaded that district, and overthrew the O'Helys, who were the occupiers of the country. Reference was next made to Magherow, in the barony of Carbury. It was the country which divided the north and west. It was frequently invaded by O'Neill and Tyrconnel from the north, and by the Macdonoughs and O'Connors from the west. Through this district they passed when invading each other's territory. In a country like this, so much exposed to invasion, there are a great many forts ; and the lecturer proceeded to show the several types of forts situated in this district, and the various stages of progress in fort-building, or evolution as applied to fort construction. Here we have an example of a simple ring fort, another of a rath with central mound and encircling moat ; another of the same kind, but with this addition, that within the mound was constructed a crypt or vaulted chamber, underneath the dun, to be used as a place of concealment or storehouse, or for both.

The next structure described was a dun, with the remains of two concentric moats around, and intervening fosse, which could be filled with water. It is called Dunfore. On the top of this ancient earthern fort was erected, at a later period, a bawn, built of stone and lime. It is square, with circular flanking towers at the angles, and a fine circular Norman arch or entrance gateway. In virtue of its dual character it has

another name, and is also called bovawn or bawn. The next type of fort in this neighbourhood was a cashel. It is almost in ruins ; but there are a series of very interesting underground chambers, of which plans and measurements were shown. This cashel is situated in the townland of Clochboley. The next example was a fortified house of the early part of the seventeenth century, called Ard Tarmon ; it is the original seat of the Gore family. It forms a connecting link between the Norman castle and the modern mansion ; photos were shown of it. After referring to the crannoges in Glencar Lake, which were used as defensive structures, the mode of construction of crannoges was explained, and several other examples given, in County Cavan and other places. The round towers in point of time came after the cashels, and before the castles. Mention was made of their uses, one of which was as places of refuge in case of sudden attack for the clergy and other ecclesiastics, as they are always found associated with ecclesiastical structures. The early circular Norman towers, such as Reginald's Tower, Waterford ; King John's Castle, Limerick; and Nenagh Castle, came in after the round towers, and before square towers were built. Views were shown of typical Norman castles, such as King John's Castle, Trim ; also Carlingford Castle, Dundrum; Carrickfergus, Creencastle, County Down, and Ballymote, County Sligo. Castles built by the Irish were next reviewed—Donegal Castle built by the O'Donnels, Doe Castle by the MacSwynes, M'Dermott's Castle in Lough Key, Breffny Castle built by the O'Rorkes near Dromahair, Castle Deargin by the Macdonoughs, Maguire's Castle near Enniskillen, Blarney Castle by the MacCarthys, &c. In form the early Norman castles resembled those of England and Wales, the original type being the castellated structures of Italy after the decline of the Roman empire. They consisted of a keep, a large and lofty building, square or circular in plan, generally the former, occupying the centre of a large enclosure frequently of several acres, surrounded by a high and parapeted wall, and flanked at intervals and at the angles by large circular towers, the whole surrounded by a moat, or occupying

the summit of some steep natural declivity. The entrance was by a circular or pointed arch between two circular towers, and protected by a barbican or advanced castellated structure. The finest example of this complete fortified castle of the Norman period in Ireland is King John's Castle, Trim, built by De Lacy, early in the thirteenth century. The keep is very bold and massive, square in plan, with a small square tower in the centre of each side wall. The walls are upwards of thirteen feet thick, roughly squared and cornered, but not dressed. In these castles the rooms that were used as reception rooms in the day were turned into sleeping apartments at night. The term "a shakedown" had a real significance at this period, as the ordinary retainers had a shakedown on the floor, the knights and warriors having frequently no better accommodation, the dressing-room being somewhere convenient to the draw well, or what in later times was known as the pump. The square towers replaced the round in churches as well as castles in the thirteenth and fourteenth centuries. The yellow steeple at Trim, which was a square tower attached to the abbey, was as strong as any ordinary castle, and on many occasions was used for defensive purposes. A description was next given of the houses the people lived in, made of wickerwork or rods, and plastered over with clay; also timber houses roofed with shingles.

The lecturer concluded by giving a description of Tara in the reign of Cormac M'Art, in the middle of the third century, and said three thousand persons each day was the number that Cormac used to maintain in pay, besides poets and satirists, and all strangers who sought the king; Gauls, and Romans, and Franks, and Frisians, and Lombards, and Albanians, and Saxons, and Picts; for all these used to seek him, and it was with gold and with silver, and with steeds, and with chariots that he paid them off. Amongst those strangers who visited Cormac's Court, probably amongst those designated Romans, was some early apostle of the Christian faith, who perhaps had travelled from Italy to Britain, and from thence to Erin. Some of these early martyrs who, taking their lives in their hands, reached this far-off isle of

the sea, taught the monarch some knowledge of the true God, for Cormac gave instructions to his people that after his death he should not be buried with his ancestors, because they worshipped trees and fountains, and stones. Had he not acquired some knowledge of the Christian faith he would not likely have given such reasons and instructions to be observed by his people. It is related that he was not buried in the great pagan cemetery on the Boyne, where all the Milesian monarchs up to that time were buried.

As Irishmen we have a right to feel proud of our country, formerly known as the Island of Saints, a country which both colonised and christianised Scotland in the time of the Picts—a country which at one time had subjugated not alone Wales but South Britain. Did not Dathi, an Irish monarch, and the last pagan King of Ireland, lead his victorious army as far as the Alps, where he was killed, it is said, by a flash of lightning whilst attacking a castle? From thence his devoted followers carried his remains back to Erin, and buried him in the cemetery of his fathers at Rath Croghan, in the present County of Roscommon. Our country was renowned as a seat of learning and sanctity; the missionaries from Erin, from the seventh to the tenth centuries, travelled to the continent of Europe, where religion had decayed, and taught those people again a knowledge of the faith. It remains for us, their descendants, to emulate them in their religion and virtues, in their learning and culture, and all their other noble qualities, as far as in us lies; and to discard everything that tends to strife and animosity amongst our fellow-countrymen, for the races are so intermingled that we cannot say we are Celts or we are Saxons, but a race that possesses all the qualities that pertain to both, and which have placed so many noble Irishmen in the very foremost rank as orators, poets, statesmen, and warriors.

The lecture was illustrated by a number of beautiful limelight views by Mr. J. Meneely; and a number of recent archæological finds, including bronze weapons, utensils, and ornaments, and also a richly-illuminated Irish MS., were shown by Mr. Milligan.

11th April, 1888.

John Brown, Esq., in the Chair.

Professor Fitzgerald read a Paper on

THE ACTION OF SCREW PROPELLERS.

Professor Fitzgerald dealt with the ideas that underlie the mechanics of the subject. The first fundamental idea in the matter is that if the propeller pushes the ship forward it must push the water backwards. That idea, he pointed out, has been sometimes forgotten, and was first brought out distinctly by the late Professor Rankin.

J. H. H. Swiney, Esq., Bac. Eng., T.C.D., also read a Paper on

THE MECHANICAL REMOVAL OF DEPOSIT FROM WATER MAINS, AS CARRIED OUT AT OMAGH IN 1887.

For some time previous to the Autumn of 1886 the town of Omagh had been suffering from a water famine, and the sanitary authority, who attributed this to the increased and increasing number of house services, together with the small size of the main supply pipe, instructed Mr. J. L. D. Meares, C.E., of Newry, and myself, to examine and report as to the cost of laying down a new main.

The existing main was 6 inches internal diameter, with a length of 4312 yards, and a fall of 216 feet. As the population to be supplied did not much exceed 4000, this pipe should under ordinary circumstances have been sufficient. My first idea was that there might be some local stoppage such as stones or air, but an examination of the pipe revealed the fact that it was choked up from the reservoir to the town by a deposit of peat and iron oxide, which formed an annular ring about 1 inch thick round the inside of the pipe. I therefore recommended that the pipes be cleaned by scraping them with one of the scrapers manufactured by the Glenfield Company, of Kilmarnock. This advice was adopted by the sanitary authority, and I was ordered to proceed. My first operation was to get in hatchboxes, three of which I inserted on the main. These consist of a casting about 4 ft. 7 in. long, with spigot and faucet ends, and a moveable cover secured by bolts to admit of the insertion of the scraper. This latter consists of two pistons kept apart by a hollow distance piece, in front of which is a spindle on which are mounted a series of scraping blades. The pistons are furnished with leather packing loaded with lead, and fitting the main so as to prevent too much leakage, which, if unchecked, would reduce the driving power,—a great inconvenience in a small main. A little escape is, however, necessary to wash away the deposit removed by the knives in front. The knives are arranged in two sets. They consist of a steel band terminating with the knife which is curved and forked, and secured to the plate by bolts passing through lugs in the web of each blade. The bar carrying the scrapers is bolted up to the piston rod, which gives it a little play going round curves.

After inserting the hatchboxes and before beginning the scraping, I carefully gauged the discharge of the pipe at its entrance to the town, and found it to be 14·57 cubic feet per minute.

The scraping operations are simple, although in the case of a pipe in which no provision has been made for such work they are slow and troublesome. In the first operations the knives were set

to $5\frac{1}{4}$ inches diameter and the smaller pistons used. The scraper was inserted at the upper hatchbox and travelled down with a low rumbling noise to a point where the main suddenly drops into and passes under the river. At this point it stuck, the bend being too sharp. The pipes were cut, the scraper removed, and bends with larger radii inserted. The scraper was again started at the reservoir and travelled down safely to the hatchbox placed about midway between the reservoir and Omagh, carrying before it an enormous quantity of peat and iron rust, which was discharged at the latter point. The larger pistons were now fixed on the scraper, the knives set to $5\frac{1}{2}$ inches, and the apparatus started at the reservoir. It pursued its course steadily for about 1,100 yards when it was suddenly stopped by striking against something with a heavy thud. On locating its position with a long stethescope (which can be easily done when the pipes are at ordinary depths, owing to the hissing noise of the water passing the pistons), I had the pipes cut, and found on the inside a projection consisting of indurated tar and sand, past which the pistons could not get. This was cut out, a new pipe inserted, and the scraper started again. It had not, however, gone 300 yards when it was again stopped by a similar defective casting. On this being removed, the scraper passed safely to the middle hatchbox; and, although I sent the scraper several times between these hatchboxes again, I had no further stoppage or delay.

It would be mere repetition to enter into the details of the operation of cleansing the main from the middle hatchbox to that in the town. Suffice it to say I was stopped twice by the defective castings before described, and once by a piece of lead weighing over 15 lbs., which had through bad workmanship got into the pipe while making a joint. Having removed all these obstructions and passed the scraper without stoppage through this length of the main, I had the middle hatchbox closed, and inserted the scraper at the upper hatchbox, when on turning on the water it made the run through to town without a single stoppage, covering the distance in 47 minutes. In its course it cleared off a little iron oxide, but not more than enough to discolour the water, so I considered the process complete.

I now guaged the discharge of the main as before, and it gave 52·53 cubic feet per minute, or nearly four times the quantity discharged before scraping.

The total cost of scraper, hatchboxes, &c., &c., and all labour came to £53 3s. 8d., but with the permanent obstructions removed and the appliances all to hand, the cost of the same work now would probably not exceed £2, and I have recommended the sanitary authority to have the work done at least every two years.

Mr. S. F. Milligan, M.R.I.A., next gave a short communication relative to a

RECENTLY DISCOVERED OGHAM INSCRIPTION IN COUNTY TYRONE.

Mr. Milligan said that since the 6th March last he had the pleasure of visiting Castlederg, County Tyrone, which he had referred to on a previous occasion. In that district there are very many antiquities of bygone days in connection with the people who lived in this country before the Christian era. There are only two Ogham inscriptions known in Ulster similar in nature to the one he had found at Castlederg, and a fac-simile of which he exhibited. One is in County Derry, in the townland of Kilderry ;—the other is in the Parish of Kilbride, Co. Cavan, three miles from the town of Oldcastle, on the road to Kilnaleck. This is known to the country people as the Cloch Stuca, and was first made known to archæologists by our fellow member Mr. Elcock. Even during the Christian era Irishmen had a mode of making known their ideas to one another by ilnes made on wood, which although not as lasting as the tablets of Nineveh, are far more enduring than paper. It is very difficult to decipher these lines—a difficulty which is experienced by even the best Irish scholars of the present day. He concluded by stating that it was his intention to forward a copy of the Ogham inscription which he had found at Castlederg to the Royal Irish Academy, where he hoped it would be deciphered.

Lecture on FACIAL EXPRESSION.

By A. W. Hare, M.B., &c., Professor of Surgery in the Owens College, Victoria University, Manchester.

The practical study of the expression of the human face, as an index of the quality and intent of the mind that is living and working behind it, is one that has been engaged in from time immemorial by the members of our race, and one in which we unconsciously or consciously are no less constantly exercising our mental powers. This practical study has been an essential element in human life since that far-off day when the social instincts of our nature asserted themselves and drew men together to live in communities, where each and all were alike concerned in upholding the common good. For the most part that study has been pursued in a purely practical and utilitarian spirit, the intense momentary importance of a right interpretation of expression in others having to a great extent displaced any thought of a more systematic enquiry into the how, or the why, or as to whether there were, in fact, any ulterior significance in the facial expression of emotion, or anything more to be gained from its study than a practical means towards effecting some immediate object. But the analogies drawn from the study of other human capacities that have for long been the subject of most interesting enquiries, as, for instance, the mechanism of locomotion, the physics of respiration, and the ultimate chemistry of that and of many other vital processes, have naturally led to the supposition that the study of physiognomy, as regards its essential character, and the *rationale* of its influence in human activities, will yield no less valuable results to the student. As far as the study has advanced in the meantime, that anticipation has been amply fulfilled ; and, as in every other branch of experi-

mental enquiry, so here has it been found that the further knowledge advances, the more scope does there seem to be for yet further useful enquiry.

The investigation of the subject is of necessity an analytical process,—one involving a close study of the anatomical structures concerned in expression ; and a clear apprehension of their action under the influence of nerve force ; to which at the same time must be added a general classificatiou of human passions by which the various qualities of nerve force are called into activity. To some minds this study will be distasteful. "What!" such an one might reasonably exclaim, "are we not to be satisfied with far-reaching enquiries into the subtly-woven structure of the body ? Must the soul also yield herself to the processes of dissection, and must the warp and woof of her gauzy tissues be separated thread by thread ?" Of such an opinion would doubtless have been the last and sweetest singer of the German school of romantic poetry : who, in describing a certain physiognomy, says, "it was not a face that one saw, but a soul." With the poet's rapid insight he saw only the intense spirituality that expressed itself in the material ; he was sublimely unconscious of the mechanism by which that revelation came within the reach of his senses. If we wish to discuss with adequate exactitude so delicate a topic as the expression of human emotion, we must ourselves be in a calm and unemontional frame of mind. We, must for the nonce, dismiss the poetical, and adopt, if not a prosaic, at least an intensely practical way of thinking ; for an enquiry so subtle can only be conducted by a steady unbiassed judgment, just as the delicate experiment of the physicist can only be performed by trained untrembling fingers and its results recorded by instruments of mathematical precision.

Now it is important to enquire at the outset what we actually understand by the term Facial Expression. I shall venture to answer the question by defining it as those associated qualities of permanent form and of postural potentiality in the face that convey to the beholder an impression of the general tenor and immediate purpose of a human mind. You will observe that

though I include permanent form to a qualified extent in this definition, I am careful to distinguish between it and that much more important element in the case, the capacity for postural alterations of the various features. The element of original form, however, could no more be absolutely omitted from the study of man's face, than could that of original sin from the contemplation of his spiritual activities. At the same time there is a danger of making of the former a more important matter than the true nature of the case will admit. To illustrate this point I need only refer to the system of Lavater, elaborated on the basis of supposed resemblances in form between certain features of the human face, and corresponding (though often not analogous) structures in the heads of the lower animals. You will remember those ingenious series of graduated sketches, commencing with a frog or a bull, and ending in each case in a human face, by which the clever Swiss proved to general satisfaction that there are canine and bovine types of human intellect accompanied by a corresponding type of features ; and how quite a new interest was taken in the habits of animals involved in the comparison, since it was important to know what to anticipate in matters of conduct from those of one's fellow-men who are afflicted with a frog-like or ox-like type of countenance. This pre-Darwinian phantasy maintained itself for years in the popular mind, as a fact, not as a quaint conceit of fancy, notwithstanding the accumulated evidence that an amphibious life was not suited to men however frog-like, and that the example of Nebuchadnezzar had remained almost without a parallel in the history of our race. Lavater's system probaby caught hold of the popular imagination because it adapted itself so deftly to the conception of that reflected human nature with which we have endowed the animal world in the early moral stories of the nursery: and this idea clings to the mind to some extent even in later years, although we come to recognise that the moral sense of animals, and their feelings, differ vastly from our own, at least in degree if not also in kind. You will notice that I am here speaking only of the form of the face as an element of expression.

When we come to speak of the movements of the face we shall find that this absence of a ground for true comparison is reversed, and discover that here we have much in common with the animal world ; if not in fact a common language of expression by which we can largely understand their feelings, and they in turn can appreciate our sentiments towards themselves. I hope I have in this sufficiently emphasized the important distinction between the mere shape of a feature and its power of appropriate movement, in constituting it an organ of expression, and that I shall be able still further to show that while the former is a useful and even necessary adjunct to the total effect of facial expression, yet it by no means compares in actual importance in this respect with the vital activity that declares itself in the movements of the features. But before we leave the subject of the form of the face, I must refer to one or two other matters closely germane to our present subject. Firstly, in what light are we to consider the claims of the phrenologists, who attribute to certain local developments or non-developments of the face and head an important correlative influence upon the presence or absence of certain distinctive features of the mental economy? The system of Spurzheim, like that of Lavater, was for many years extremely popular, but like it also, it was based on a misconception. The bony thickenings found in various localities on the surface of the skull have no relation to any increase in the parts of the brain that lie beneath them, and therefore an exact delineation of character based on these appearances is no more likely to be correct than a similar estimate based on a study of height, weight, or complexion solely ; and much less likely to contain a germ of truth than the recently resuscitated science of palmistry. There is no doubt a certain amount of truth in a physical sense, and perhaps even to a slight extent in a moral, in the old saying *ex pede Herculem ;* but surely a foot is a very much more expressive token of the character of the man, and the nature of his heroic work in the world, than any concatenation of bumps and hollows on the surface of his skull! But this lecture is in no sense intended to deal with Phrenology,

which is a very wide "pseudo-science" as Oliver Wendell Holmes calls it; and I can merely remark in passing that the excellent reasons on which he bases his nomenclature are fully and pithily stated in the little essay on the subject that appears in his "Professor at the Breakfast-table." The other point that I must refer to, in regard to the form of the face, is to enquire whether there is any necessary connexion between a certain proportion among the features and the conventional idea of beauty. Taking up this question in the widest sense, it must certainly be answered in the negative. There is assuredly no standard of beauty of face that could comprise the ideals of all civilised races, to say nothing of the peculiarities that might be discovered by the curious enquirer among some of the uncivilsed. Viewed in this wide aspect, there is no solution to the problem, and one can only escape from the dilemma by the aid of the proverb *De gustibus non est disputandum.* Yet for most European races, for all at least that by descent or intellectual contact have acquired something of the Hellenic spirit, it would appear that a law of the necessary form of beauty may be laid down; and it suggests strange possibilities as to the actual origin of our sense of formal beauty, when we discover an exact mathematical principle of proportion underlying this conception. Did those clear-sighted sages who compiled Euclid and taught us how to reason, also compile the canon law of beauty and teach us the excellence of true proportion in material form, as in that of thought? To that question there is no answer now. We do not even know who formulated the truths of Euclid; yet that most witty of all scriptures remains to shew what the men of that time could do. And if we believe that Pheidias and Praxiteles were inspired by the principle of mathematical proportion, to which many of their works undoubtedly conform, we are making at least a more reasonable guess at truth than if we held the law of proportion expressed in their work to be mere coincidence, or the outcome of an instinct felt and acted on, but not understood. Into this curious enquiry I cannot further enter here, but it is interesting to notice that the researches of modern investigators

go far to confirm the supposition that a duly formulated Science of Beauty once existed among the Greeks. It is also most suggestive, as a hint for further enquiries into human capacities, to find that this law of Beauty expressed in form conforms exactly to the tonic relation of musical notes in a chord. It seems highly probable that there is a deep-lying unity of the senses ; that a similar principle underlies the activity of all of them ; and that in enjoying the perfection of a contour we may be realising a subtle sense of true proportion, that might equally express its essential nature in blended colour or harmonious sound.

Having said so much about the form of the face as affecting its powers of expression, let us now consider the movements of which its features are capable ; and in the first place the mechanism by which those movements are effected. Movements here, as elsewhere throughout the body, depend upon the presence of muscle, or contractile tissue ; and the muscular system of the face is one of the most complex and delicate of those that carry on the actual work of the body. But the muscles of the face are distinguished from all others by the delicacy of their structure, the lightness of their labour, and the great economic importance of the office they perform. Hence they may not inappropriately be termed the aristocracy of the muscular system ; for whereas other coarse grained muscles toil laboriously in lifting heavy bones and moving the levers of complicated joints, these delicate structures merely act upon a soft and pliant skin, as with deftly working fibres they throw it into furrows, and construct a charming dimple or elaborate a smile. They are so light and so respondent that the slightest breath of nerve activity sets them in motion, whereas a strong impulse is needed to awaken their more weighty neighbours to the discharge of their more massive duties. The only other muscles that compare with them are the active little group that move the eye, and those that give such quickness and precision to the movements of the fingers. In striking conformity with these facts is the law by which Herbert Spencer has attempted to explain how it is that the face is in so especial

a manner singled out as the chief exponent of psychic activities. He considers that in the overflow from the seat of consciousness of the nerve currents that accompany emotion, those lighter structures which are most susceptible to such impulses will first shew symptoms of the disturbance that is taking place ; and that just as the psychic storm increases in intensity, so will less susceptible muscles become gradually more deeply involved in the nervous discharge, till it may happen that all become violently excited. This sequence of activities is well illustrated by the phenomena of some intense human passion, such as anger when typically exemplefied ; for it is only when the face has assumed the utmost limit of the characteristic distortion of rage, that the fingers twitch, the hands are clenched, and the foot stamped in the intensity of passion.

Thus it is that in the first instance, in the unsophisticated mortal, the face is pre-eminently the index of the soul. But people are conscious of this sometimes embarrassing fact, and take elaborate precautions to keep their faces calm even when the mind itself is ruffled by tempestuous storms. But here the discrimination of the true observer comes into play. Lavater has well remarked that " he alone is an acute observer who can observe minutely without being observed ;" and to the subtle observer of human passions the casually detected twitching of those apparently listless fingers, the tapping of that little foot on the noiseless Persian carpet, may often be as eloquent of meaning as the most passionate facial expression. We all saw that exemplified in the recent epidemic of "Thought-reading," where the fingers of the medium gave that indication to the "thought-reader" that his face so carefully and scrupulously denied. Now as regards the facial muscles, they are many in number and elaborate in their arrangement. Further, they rarely, if ever, act in an individual capacity in producing any typical expression. In fact, they so habitually act in concert that it would be impossible to assign its proper function to each, were it not for the fact that they can severally be thrown into individual activity by artificial means. This method of studying their various actions was devised by M. Duchenne, who,

by applying a slight electric shock to each muscle individually, caused it to give up the secret of what action it was for which it had been specially adapted. He found that the action of any single muscle alone would not produce a characteristic expression of human feeling, but that, as in music, so here the overtones of expression must be added to give full significance to the fundamental note of feeling first hit upon. His researches shew that most of these characteristic expressions involve movements about the mouth combined with correlated movements of the nostrils and the eyes. This corresponds accurately with what Sir Charles Bell pointed out early in the century, that the facial muscles are divisible into three natural groups, each group in turn consisting of two antagonistic series of muscles acting respectively towards, and away from, the apertures of the mouth, the nostril, and the eye. He further shewed that a certain class of mental activities is associated with the action of the retracting muscles, and a contrary class with that of the contracting series ; while contending impulses opposite in their character, often produce those uncertain tremors of balanced activity so characteristic of an undecided frame of mind. Speaking generally, the retracting muscles are associated with amiable impulses, the contracting group with the opposite. But it is to be noticed that in hardly any case can one glean the full significance of an expression from the action of one feature alone : hence it is by no means easy to ascribe a leading part in expression to any one of them. Practically, however, I think it will be found that the mouth gives as it were the key-note of the expression, whether grave or gay : and that one must look to the subtler significance of the eye to determine precisely the type of gaiety or gloom present in each case. It is said that some people smile with their eyes only ; but does not such an expression convey rather an anticipatory conception of what may be, than the actual sense of organic satisfaction in the accomplished fact, where the mouth smiles too ? Of the converse, I need hardly speak ;— a smiling mouth, with hard cold unsmiling eyes, is not an attractive expression, as a true smile should always be. Thus

at times the very discord between the language of separate features may lead not to confusion but to a clearer interpretation of the character they betray. The stern forbidding mouth of the resolute soldier who would flinch from nothing that lay in the path of duty, might be rather admired than loved ; yet the kindly eyes above it may all the more attract from their very contrast. But here I am touching on a side issue, and one of great interest and importance ; the origin and meaning of habitual expressions. As in other muscular exercises so in those affecting the face, any movement frequently made is more easily repeated than the production of new combinations of movement. In course of time, frequent repetition causes such movements to be unconsciously performed and finally habitual. In this way a man's history may become legibly written in his face ; any preponderating emotion or experience leaving its mark in some habitual posture of one or other of his features. Thus the slight contraction of the brows that often accompanies intense thought may become a permanent factor in the expression of a face ; and it was doubtless such a peculiarity that gave rise to that which Tennyson describes in his friend's face as

> "Over those ethereal eyes
> The bar of Michael Angelo."

In marked contrast to this manner of expression, the "mark of loyal nature and a noble mind," are those cases where the self-conscious villain uses his face as a mask for, not an index of his mind. In such instances the soul may as it were fall a victim to its own duplicity ; and men may come to complain, as does Browning's hero in "a soul's tragedy," of "features which refuse the soul its way." In the middle ages we find a quaint method of reading character recommended by Campanella, whose prescription was to imitate closely with one's own features the expression one wished to interpret, and at the same time by a process of introspection to discover what attitude of the mind corresponds to the given attitude of the features. Apart from the grotesque effects produced in putting it into practice, such a method would be very misleading, for it is impossible to replace

one's own past experience by the antecedent emotions of another mind. Yet this method brings out an important point in regard to facial expression as a training to the mind. It is very hard, if not impossible, for an unsophisticated person to assume any other expression than that which interprets the present state of the mind ; it is difficult to look happy and feel sad. If to look happy is not to be happy, it is a very short step from the one to the other. Hence it is very important in the psychological training of children to study their expression, and above all to prevent by every possible means, the growth of a permanently ill-natured expression. It is the surest way to guard against the development of every kind of malefactor in the future ; and it is a matter in which every human being is a responsible agent. This responsibility is two-fold ; it is not only a duty to remove any cause for the unhappiness that the expression may betray ; but, if I may so put it, to set a good example oneself in the matter of a happy expression. For one of the most interesting points connected with the various facial expressions is their contagiousness. Such movements as yawning are eminently contagious. So, to a great extent, are laughter and smiling. I take it, therefore, that it is a duty which every member of society owes to society at large, at whatever cost of self-denial, to carry about a benign type of facial expression ; for in it we possess one of the most potent educative agents for the mind ; more potent it may be in promoting that which is good and desirable in human life than all our vaunted machinery of school boards and secondary educational system. Such are some of its imperative uses, and some of the conditions of its present study ; but we cannot quit this interesting subject without a short reference to the probable origin of facial expression in the far past history of our race. Sir Charles Bell was satisfied in seeing in it a special adaptation of structure and function to the social necessities of human life. Not so Darwin and Spencer. In the writings of both are to be found most interesting and ingenious surmises as to how the various expressions now recognised as distinct and opposite in their meaning became associated with the corresponding places of

mental activity. I must confess that to my own mind some of their theorisings appear a little unpractical, and some of their assumptions a little gratuitous. Yet one must highly value any basis on which even to think, when the mind is projected backward into the mysterious abyss of pre-historic, perchance pre-human, existence. Let us take the instance of the origin of frowning and the knitting of the brows associated with unpleasant mental impressions. Whether, with Spencer, we see in it the shielding of the eyes from the level sun-rays that lit the arena of ancestral conflicts ; or, with Darwin, the protection of a super-imposed covering to the swollen eyeballs of some weeping infantile progenitor of our race, I think we are perhaps taking more for granted of that early pre-human nature than facts will clearly verify. To fight was probably then a pleasure, and anything but an unpleasant employment ; and consequently it should have handed us down the smile rather the frown. But though it is easy to criticise, it is difficult to substitute any better theory ; and, as I said, we owe to these great thinkers our only access to that attenuated region of thought ; which though so high, is yet so attractive and so full of possible discoveries. For is it not possible that when we can more fully interpret the language of expression, we shall be able to write a still older chapter of human experiences, than the delightful chapter the philologists have given us from their study of words? for facial expression is an older language than speech.

And is not this another instance in which the conundrum, set of old to man, "Know thyself," presses urgently for a solution ? For in this study, so great in its present interest, so fertile in its interpretation of our nature, we may find traces of of the deep meaning of the past ; perchance even indications for the future, pointing ever towards that

> "Far-off divine event
> To which the whole creation moves.

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OF THE

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NATURAL HISTORY & PHILOSOPHICAL SOCIETY

FOR THE

SESSION 1888-89.

BELFAST:
PRINTED BY ALEXR. MAYNE & BOYD, 2 CORPORATION STREET
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The Museum, College Square North, is open daily from 12 till 4 o'clock. Admission for Strangers, 6d. each. The Curator is in constant attendance, and will take charge of any Donation kindly left for the Museum or Library.

Belfast Natural History and Philosophical Society.

ANNUAL REPORT, 1889.

The Annual Meeting of the Shareholdcrs of the Belfast Natural History and Philosophical Society was held on 13th June, 1889, in the Museum, College Square North. Professor Letts, Ph.D., *President*, occupied the chair. There were also present:—Messrs. Thomas Workman, J.P.; John Anderson, J.P.; Robt. L. Patterson, J.P.; W. H. Patterson, M.R.I.A., John Rowan, J. H. Greenhill, Mus. Bac.; William Swanston, F.G.S.; Robert Young, C.E.; R. Ll. Praegar, Isaac Ward, R. M. Young, B.A., *Hon. Secretary;* John Brown, *Hon. Treasurer*, &c.

The President occupied the chair, and intimated that at that stage of the proceedings he would satisfy himself and consult the interests of the meeting by calling upon the Hon. Secretary to read the Annual Report.

The Secretary, having read the notice convening the meeting, submitted the Annual Report of the Council, which was as follows:—

"The Council of the Natural History and Philosophical Society, appointed by the Shareholders at the Annual Meeting, held on June 27th, 1888, desire to submit their report on the working of the Society during the past year. The ordinary Winter Session was opened on October 30th, 1888, when Rev. William F. Johnson, M.A., Armagh, read a paper on 'Irish Insects,' illustrated by specimens from his collection. The second meeting was held on December 4th, 1888, when Mr. John Brown gave a lecture on 'Soap Bubbles,' with experiments.

The third meeting was held on January 8th, 1889, at which Rev. A. Gordon, M.A., read a paper, entitled 'Notes of Spanish Travel, 1888.' The fourth meeting was held on February 5th, 1889; Mr. Thomas Workman, J.P., gave a paper—subject, 'A Visit to Singapore,' with limelight photographic illustrations; and Dr. John Moran read a short description of the finding, by himself, of a mammoth's tooth in the drift gravels at Larne. The fifth meeting, an extra one, was held on February 26th, when Dr. John MacCormac gave a lecture on 'Man's Food and Dietetics,' followed by a short communication from Mr. Robert Young, C.E., on 'A Recent Section of the Upper Boulder Clay at Greencastle Waterworks,' with specimens. The sixth meeting was held on March 5th, when Mr. Seaton F. Milligan, M.R.I.A., read a paper on 'The Sepulchral Structures and Burial Customs of Ancient Ireland,' illustrated by special photographic lantern views. The seventh meeting, also an extra one, was held on March 19th, when three subjects were brought forward —Mr. Allan P. Swan read a paper on 'The Fungus of the Salmon Disease: its Life and Function,' with microscopic lantern illustrations; Mr. John Brown gave an account of 'Figures Produced by Electric Discharges on Photographic Plates;' and Messrs. John Brown and William Gray exhibited and described the optimus optical lantern, Leache's oxyhydrogen microscope, and an aphengescope. The eighth and concluding meeting was held on April 2nd, when Professor Meissner read a paper—subject, 'Christian Antiquities and Works of Art of the Lower Rhine,' illustrated by drawings, &c.

"In addition to the ordinary meetings, your Council made arrangements to continue the customary special series of Popular Scientific Lectures, of which three were given. The efforts of the Society in connection with these lectures have been fully appreciated by the members and the general public, as shown by the large attendances. The first of the series was held on November 28th, 1888, in the Ulster Minor Hall, when your President kindly gave a lecture on 'Alchemy and Alchemists.' The second of these meetings was held on January 17th, 1889, when

Mr. James Ward, head master of the Government School of Art, Macclesfield, gave a lecture in the Ulster Minor Hall on 'Decorative Art,' illustrated by designs,' &c. Sir William Thomson, LL.D., F.R.S., kindly arranged to give the concluding lecture of the series on April 16th, when he lectured in St. George's Hall, on 'Gyrostatic Experiments,' to an appreciative and representative audience. Mr. James Meneely and several other friends gave valuable assistance at these meetings.

"As may be seen from the Hon. Treasurer's Statement of Accounts, the increase in the membership continues to progress.

"Your Council have again let the room known as 'The Library' to the Ulster Medical Association on the former conditions, reserving access for the members at all times. The other societies having their meetings in the Museum have been augmented by the addition of the Ulster Beekeepers' Association.

"With the kind assistance of some members and other friends (including Mr. Hugh Porter and Professor Meissner), an interesting collection of pictures was shown on Easter Monday and Tuesday at the Museum, which was open at the usual nominal charge. A sum of nearly fifty pounds was realised, in which are included the proceeds of the sale of 475 copies of 'The Visitor's Guide,' recently prepared by Mr. S. A. Stewart, F.B.S., Edin. This contains short descriptions of some of the principal objects of interest in the Society's collections, and will in future be presented to visitors at the Museum.

"The Council considered that the occasion of the visit of their distinguished townsman, Sir William Thomson, was a fitting opportunity to enable the Society and its friends to meet himself and Lady Thomson at a conversazione held at the Museum on April 17th, when a large number were received by the Mayor (C. C. Connor, Esq., M.A.) and Mrs. Connor. Especial thanks are due to those friends who so kindly assisted to make the evening a success.

"A list of donations to the Museum and of publications which have been received from various Philosophical and Scientific Societies with which we are in correspondence is printed with

this Report. Especial reference should be made to the acquisition, on permanent loan, of the 10-ton trial armour-plate, from her Majesty's Dockyard, Portsmouth, procured by the kind influence of Sir James P. Corry, Bart., M.P., from the Admiralty, and which now forms a striking object at the Museum entrance. It was formally unveiled by the Mayor on 17th April, and a full report of the proceedings was duly published in the newspapers. The Council desire in this connection to thank the local Press for the admirable manner in which the lectures of the Society are reported. Amongst the donations to the Society may be mentioned the valuable series of early volumes of the *Belfast News-Letter*, presented by the kindness of the Misses Mackay, Fortwilliam ; Rev. W. F. Johnston's additions to the Society's collections of Irish coleoptera, which he also kindly re-arranged ; and Captain Robert Campbell's interesting gifts. The Council desire to thank the various donors for their kindness in presenting so many valuable objects to the Museum.

"Your Council now retire from office, and this meeting will be asked to select fifteen members to form a new Council."

The Hon. Treasurer presented the Financial Statement, which showed that the Society at the end of the year had a balance in their favour of £8 13s. 11d., which was a great improvement on their position of the previous year, considering that there was then a balance on the wrong side of between £15 and £16. The income this year was less, but it is highly satisfactory to know that the receipts at the door had increased. The subscriptions were encouraging, whilst the success of the lectures was a remarkably encouraging feature in connection with the Association. He (Mr. Brown) trusted that the year upon which they had now entered would be even more prosperous than the last, and he believed he could see a way to reduce the expenditure.

The President said he might perhaps be allowed to make a few remarks on the Report before its adoption was finally moved. He thought they had good reason to be satisfied with the year's work, and with the position and prospects of the Society. They

could not, he feared, maintain that this city was a great centre of learning and scientific investigation, or that there was an extraordinary interest taken in scientific matters. But there was undoubtedly a small circle who did take such an interest, and it was one of the functions of the Society to educate public opinion there, and this, he thought, they strove very hard to do with the limited means at their disposal. At their meetings of this year they had had several papers of real interest, and one or two describing valuable original observations. This was an excellent sign, and the Society ought to have a number of such contributions. Belfast is the centre of a district of great interest to the student of natural history, of geology, of mineralogy, and of archæology, so that there is an excellent field for original observation and work. Surely, too, the local industries, which depend so largely upon scientific principles, ought to furnish matter for original contributions to their meetings. When a great vessel like the *Teutonic* was built were there not some new points of scientific interest brought to light which their Society might have the advantage of bringing before the public? That the papers read at the meetings of the Society had been of interest—he might say of great interest—was proved by the large audiences who had listened to them, and a similar remark applied to the series of lectures that had been given. The Society was to be congratulated on securing as one of its lecturers for the past year a man of such universal reputation as Sir William Thomson. He (the President) said last year, and he repeated it now, that they ought to have a more suitable building and a proper lecture theatre of their own. Surely there ought to be one or many of their townspeople willing to give assistance in this matter, and he thought their claim was a very strong one. In conclusion, he had only to say that many valuable donations had been made to the Museum; that there was a balance as regarded money, which, though small, was not on the wrong side; and that, thanks to the great energy and interest taken by their Treasurer and Secretary in the affairs of the Society, and also, he hoped, to the growing esteem in which they were held, the roll of membership continued to enlarge.

Mr. ANDERSON, in proposing the adoption of the Report and Statement of Accounts, said he was sorry that his attendance during the last Session or two had not been very good, but that was no indication that he was not as enthusiastic in the work of the Society as ever he had been, for he saw from the Press, and heard from members how they were progressing, and he was heartily glad to know that their position in the circumstances was very satisfactory. It was highly gratifying to know that the popular lectures had been appreciated so well by the inhabitants of Belfast, and he believed the attendance in the past was a good augury of what might be expected in the future. He (Mr. Anderson) was delighted to know that the Misses Mackay had presented the Society with a series of early volumes of the *Belfast News-Letter*, which could not fail to be full of interest, and he hoped that others would follow such a commendable example.

Mr. ROWAN seconded the motion, which was agreed to unanimously.

The PRESIDENT said it might be the wish of the meeting that the Secretary should read out a list of the donations that had been received. (See page 8.)

A vote of thanks to the Chairman terminated the proceedings.

Dr. *The Belfast Natural History and Philosophical Society in Account with Hon. Treasurer For the Year ending April 30th, 1889.* **Cr.**

EXPENDITURE.

	£	s.	d.
To Balance due Treasurer	£15	16	2
To Cash paid Insurance Premiums	6	12	0
,, Printing Report	12	9	6
,, Advertising	15	8	5
,, Printing and Stationery	13	6	7
,, Water Rate	2	4	7
,, Collector's Commission	5	4	9
,, Expenses on Specimen Armour Plate	4	5	10
,, Expenses at Easter	11	18	3
,, Carriage on Donations, Repairs, and Sundries	9	7	6
,, Donation to Amateur Photo. Society Prize Fund	1	1	0
,, Postage and Telegrams	5	1	7
,, Fuel and Gas	12	3	8
,, Wm. Darragh, Salary till April 30th	48	0	0
,, S. A. Stewart, ,, ,, less two week's leave	47	10	0
,, Rent till April 30th	25	0	0
To Balance	8	13	11
	£244	3	9

RECEIPTS.

	£	s.	d.
By Interest on Loan to York St. Spinning Co.	£19	10	8
,, Proceeds of One Share sold	7	0	0
,, One Copy of Report sold	0	1	0
,, Transfer Fees	0	19	0
,, Donations	11	10	0
,, Subscriptions	116	5	0
,, Entrance Fees at door till 30th April	17	2	6
,, Do. on Easter Monday	39	14	5
,, Do. on Easter Tuesday	8	2	8
,, Contribution from Ulster Amateur Photo. Society	3	13	6
,, Contribution from Naturalists' Field Club	5	5	0
,, Do. Ulster Medical Society	15	0	0
	£244	3	9
By Balance in Treasurer's hands	£8	13	11

Examined and found correct.

June 12th, 1889.

WM. H. PATTERSON,
SAMUEL ANDREWS, } *Auditors.*

J. BROWN, *Hon. Treasurer.*

DONATIONS TO THE MUSEUM, 1888-1889.

From MRS. ANDREWS.

Portrait of the late Dr. Thomas Andrews, F.R.S.

From JOHN BROWN, Esq.

Fossil tooth of a hyena from bone cave at Cresswell Crags.

From Mr. CHARLES BULLA.

Specimens of fossil plants from the local eocene beds and cones of allied existing species.

From THE BELFAST ROYAL ACADEMICAL INSTITUTION.

Montagu's British Testacea, Donovan's Natural History of British Fishes, and Cuvier's Ossemens Fossiles, vol. 5.

From J. H. DAVIES, Esq.

Annals of Botany, vol. 2, part 7.

From Surgeon-Major Dr. CHAS. D. GROSE.

Two specimens of the bearded vulture, and one specimen of Impeyan pheasant (*Gypœtos barbatus*) from India.

From MRS. HERDMAN.

A pair of globes and 166 casts of medals.

From MRS. HONEYBURN.

Ancient chalice of Kilclief Church, County Down.

From THE MISSES MACKAY.

The volumes of the *Belfast News-Letter* from 1805 till 1819, inclusive.

From R. LLOYD PATTERSON, Esq., J.P., F.L.S.

Seebohm's recent work on plovers and sandpipers.

From THOMAS KYLE, Esq.

Two specimens of ore from Nevada, a tarantula and a tarantula's nest, a large specimen of silicified wood from the petrified forest in California, rattlesnake's tail, emu's egg, section of the bark of one of the giant trees of California, a skeleton leaf, &c.

From W. H. Patterson, Esq., M.R.I.A.

A number of British recent shells, a bottle of gulfweed (*Sargassum*), several snakes, and a number of insects, preserved in spirits, from Queensland.

From W. Swanston, Esq., F.G.S.

An ancient bronze vessel, found in County Down.

From Thomas Workman, Esq., J.P.

A number of land and fresh-water shells from Singapore, a flint knife from New Guinea, two quartzite knives (North Queensland), several nests of trapdoor spider, specimens of land and fresh-water shells from Madagascar and from Brazil, insects and fish from North Australia, snake from Burmah, and several snakes from North Australia.

From Joseph Wright, Esq., F.G.S.

Two fossil ammonites and one fossil orthoceras.

ADDITIONS TO THE LIBRARY, 1st MAY, 1888, TILL 1st MAY, 1889.

Adelaide.—Transactions and Proceedings of the Royal Society of South Australia, Vol. 10, 1886-7. *From the Society.*

Belfast.—History of the Linen Hall Library. *The Belfast Society for Promoting Knowledge.*

Proceedings of the Belfast Naturalists' Field Club. Ser. 2, vol. 3, part 1, 1889. *The Club.*

Berlin.—Verhandlungen der Gesellschaft für Erdkunde. Vol. 15, parts 4-10; and vol. 16, parts 1 and 2, 1888-9. *The Society.*

Bremen.—Abhandlungen Herausgegeben vom Naturwissenschaftlichen Vereine zu Bremen. Vol. 10, parts 1 and 2, 1888. *The Society.*

Breslau.—Zeitschrift für Entomologie, Herausgegeben vom Verein fur Schleische Insektenkunde zu Breslau, 1888. *The Society.*

Brussells.—Bulletin de la Societe Royale de Botanique de Belgique. Vol. 26, part 2, and vol. 27. 1887-8. *The Society.*

Comptes Rendus des seances de la Societe Entomologique de Belgique. Series 3, Nos. 99-102, 1888. *The Society.*

Annales de la Societe Royale Malacologique de Belgique. Vol. 22, 1887; and Proces-verbal des seances, vol. 17, in part, 1887-8. *The Society.*

Calcutta.—Records of the Geological Survey of India. Vol. 21, parts 2-4, 1888; and vol. 22, part 1, 1889.

Memoirs.—Palæntologia Indica. Ser 13, parts 1 and 7, 1887.

A Bibliography of Indian Geology, 1888. *The Director of the Survey.*

CAMBRIDGE, U.S.A.—Bulletin of the Museum of Comparative Zoology. Vol. 13, nos. 9 and 10; vol. 16, nos. 1 and 2; vol. 17, nos. 1 and 2, 1888; and Report of the Curator, 1887-8.

From the Curator.

CARDIFF.—Report and Transactions of the Cardiff Naturalists' Society. Vol. 19, part 2; and vol. 20, part 1, 1887-8. *The Society.*

CHRISTIANIA.—Forhandlinger I. Videnskabs Selskabet I. Christiana, 1887. *The University.*

COLOMBO.—First and Second Report on the Lizards in the Colombo Museum, 1886-7.

The Museum Committee.

CORDOVA (Argentine Republic).—Boletin de la Academia Nacional de Ciencias en Cordoba. Vol. 10, parts 1 and 2, 1887; and vol. 11, parts 1 and 2, 1887-8. *The Academy.*

DANTZIC. — Schriften der Naturforschenden Gesellschaft in Danzig. Vol. 7, part 1, 1881.

The Society.

DUBLIN.—Transactions of the Royal Dublin Society. Ser. 2, vol. 3, part 13, 1887; and vol. 4, part 1, 1888. Proceedings, vol. 5 (N.S.), parts 7 and 8, 1887; and vol. 6, parts 1 and 2, 1888.

The Society.

EDINBURGH.—Proceedings of the Royal Society of Edinburgh. Vols. 12, 13 and 14, 1883-4 to 1886-7; and List of Members, 1887. *The Society,*

Reports of the Laboratory of the Royal College of Physicians, Edinburgh. Vol. 1, 1889.

The College.

EMDEN.—72nd and 73rd Jahresbericht der Naturforschenden Gesellschaft in Emden, 1886-8.

The Society.

ESSEX.—The Essex Naturalist, nos. 4-12, 1888.
The Essex Field Club.

GENOA.—Giornale della Societa di Letture. Anno 11, fasc. 1-10, 1888. *The Society.*

GIESSEN.—Bericht der Oberhessischen Gesellschaft fur Natur und Heilkunde, No. 26, 1889.
The Society.

GLASGOW.—Transactions of the Geological Society of Glasgow. Vol. 8, part 2, 1888. *The Society,*

Proceedings of the Natural History Society of Glasgow, n.s. Vol. 2, part 1, 1888.
The Society.

Proceedings of the Philosophical Society of Glasgow. Vol. 19, 1887-8. *The Society.*

IGLO.—Jahrbuch des Ungarischen Karpathen-Vereines. Year 15, 1888. *The Society.*

Wegweiser durch die Ungarischen Karpathan in auftrage des Ungarischen Karpathenvereines, by Franz Denes, 1888. *The Author.*

KHARKOW.—Travaux de la Section Medicale de la Societe des Sciences Experimentales of the University of Kharkow, 1886-8. *The Society.*

KIEW.—Memoirs of the Society of Naturalists of Kiew. Vols. 9 and 10, 1888-9. *The Society.*

KGLOZVART, Transylvania.—Maygar Novenytani Lapok. (Hungarian Journal of Botany). Vol. 12, 1888.
The Publisher.

LAUSANNE.—Bulletin de la Societe Vaudoise des Sciences Naturelles. Vol. 23, no. 97 ; and vol. 24, no. 98, 1888. *The Society.*

LEIPSIC.—Sitzungsberichte der Naturforschenden Gesellschaft zu Leipsig. 13th and 14th years, 1886-7.
The Society.

LIVERPOOL.—Synopsis of Arrangement of Invertebrates in Liverpool Public Museum, 1874.
Thos. Workman, J.P.

LONDON.—Quarterly Journal of the Geological Society, nos. 175-177, 1888-9; and List of Fellows, 1888. The Society Journal of the Royal Microscopical Society, nos. 64-69, 1888, and Index.
The Society.

Proceedings of the Zoological Society of London, parts 1-4, 1888. *The Society.*

Report of the Meeting in Bath of the British Association, 1888. *The Association.*

MANCHESTER.—Transactions of the Manchester Geological Society. Vol. 19, parts 18-20; vol. 20, parts 1-4.
The Society.

MELBOURNE.—Transactions of the Royal Society of Victoria. Vol. 1, part 1; and vol. 24, parts 1 and 2, 1887-8. *The Society.*

MONTREAL.—Annual Report of the Geological and Natural History Survey of Canada. Vol. 2, and Maps, 1886. *The Director of the Survey.*

MOSCOW.—Bulletin de la Societe Imperiale des Naturalistes de Moscow, nos. 2 and 3, 1888; and Meteorologische Beobachtungen, 1888.
The Society.

NEW YORK.—Annals of the New York Academy of Sciences. Vol. 1, nos. 1-13; vol. 2, nos. 1-9; vol. 4, nos. 3-8, 1880-88. *The Academy.*

Bulletin of the American Geographical Society. Vol. 20, nos. 1 and 4, and Supplement, 1888; and vol. 21, no. 1, 1889.
The Society.

Joseph Henry and the Magnetic Telegraph; a Memorial Address delivered at Princeton College.

ODESSA.—Memoirs of the Society of Naturalists of New Russia. Vol. 8, 1888; and vol. 13, parts 1 and 2, 1888. *The Society.*

OSNABRUCK.—Seventh Jahresberichte des Naturwissenschaftlichen Vereins zu Osnabruck, 1885-88. *The Society.*

PADUA.—Bulletino della Societa Veneto-Trentino di Scienze Naturali. Vol. 4, no. 2, 1888; Atti, vol. 10, fasc. 2, 1889. *The Society.*

PHILADELPHIA. — Proceedings of the Academy of Natural Sciences. Part 3, 1887; and parts 1 and 2, 1888. *The Academy.*

PISA.—Atti della Societa Toscana di Scienze Naturali Processi Verbali. Vol. 6, 2 parts, 1888. *The Society.*

ROME.—Atti della Reale Academia. Vol. 4, fasc. 1-13, 1888-9; and vol. 5, fasc. 1-3, 1889; vol. 6, fasc. 3-5, 1888. *The Academy.*

Journal of the British and American Archæological Society of Rome. Vol. 1, no. 4, 1887-8. *The Society.*

SAN FRANCISCO. — Bulletin of the Californian Academy of Sciences. Vol. 2, no. 8. *The Academy.*

SANTIAGO DE CHILE.—Verhandlungen des Deutshen Wissenschaftlichen Vereins zu Santiago. Part 5, 1887; part 6, 1888. *The Society.*

TORONTO.—Proceedings of the Canadian Institute. Ser. 3, vol. 5, fasc. 2, and vol. 6, fasc. 1; and Annual Report, 1888. *The Institute.*

TRENTON, N.J.—Journal of the Trenton Natural History Society. Vol. 1, no. 3, 1888. *The Society.*

TRIESTE.—Bollettino della Societa Adriatica di Scienze Naturali in Trieste. Vol. 11, 1889. *The Society.*

VENICE.—Notarisia Commentarium Phycologicum, Anno 3, nos. 11 and 12, 1888; and anno 4, no. 13, 1889.

VIENNA.—Verhandlungen der Kaiserlich Koniglichen Geologischen Reichstanstalt, nos. 5-18, 1888; and nos. 1 and 2, 1889. *The Directors.*

Verhandlungen der K. K. Zoologisch-botanischen Gesellschaft in Wien. Vol. 38, parts 1 and 4. *The Society.*

WARWICK.—Proceedings of the Warwickshire Naturalists' and Archæologists' Field Club, 1887. *The Club.*

WASHINGTON.—Smithsonian Miscellaneous Collections. Vols. 31-33, 1888. Annual Report, 1885, part 1. *The Institution.*

Notes on the use of human ordure in semi-religious rites. By Capt. Bourke, U.S.A. *The Author.*

BELFAST

NATURAL HISTORY & PHILOSOPHICAL SOCIETY

SESSION 1888-89.

30th October, 1888.

THOMAS WORKMAN, Esq., J.P., in the Chair.

Rev. W. F. JOHNSTON, M.A., Armagh, read a Paper on

IRISH INSECTS.

THE LECTURER said the insects of Ireland have not, he regretted to say, received that amount of attention which they deserve. Very little systematic collection has been done except with respect to the lepidoptera. The other orders have practically been entirely neglected, except by solitary collectors. As regards the lepidoptera, Mr. Birchall has published in the *Entomologists' Monthly Magazine* for 1867 a list of Irish lepidoptera. In this list he enumerated 961 species, and subsequently made considerable additions to this number. Since then the lepidoptera of Ireland have received a considerable amount of attention. Mr. De V. Kane has done much good work, and stirred up others in the same direction, and there are now, he thought, collectors of lepidoptera in most parts of Ireland. There is, consequently, every probability of a very complete list of Irish species being compiled. The little that we know about Irish coleoptera is largely due to the exertions of our late gifted fellow townsman, A. L. Halliday. Mr. Halliday had made a very large collection of beetles in Ireland, and it is to be very much regretted that he had turned his attention to other orders of insects; for such was

the acuteness and penetration of his intellect, and such his skill in identifying obscure and difficult species, that, had he continued to devote himself to the study of our native coleoptera, a most complete and exhaustive list would have been compiled. Unfortunately, the few lists that have been published represent almost all our knowledge of our native beetles up to the present, with the exception of a few species taken by visitors, such as the late Dr. Power, Mr. Champion, and Mr. J. J. Walker, R.N. The lecturer has for the past five years devoted most of his spare time to the collection and study of our native coleoptera, and it was his desire that evening, by giving some account of them, to induce some of the Belfast entomologists and naturalists to take up the same pursuit.

The question, "What are coleoptera?" is a very natural and proper one, and he would endeavour to answer it. The term coleoptera means "sheath-winged." In butterflies and moths all four wings are of the same substance, but in a beetle the upper pair are of a horny consistency, and the lower pair membranous. In many beetles the lower pair are not developed, or only in a rudimentary form. We must recollect that we see the membranous wings only when the beetle is flying; when at rest they are folded under the hard upper wings, which are called the elytra, and which thus form a sheath for the lower pair. Beetles pass through the same four stages as butterflies and moths—viz., egg, larva, pupa, and perfect insect. As far as appearance goes, a beetle grub might be easily mistaken by an inexperienced eye for that of a moth, as both have soft and round bodies, so that in this stage there is a certain sort of resemblance between the two orders; but in the next stage—that of the pupa—the resemblance ceases, for though the pupa of a beetle is motionless, like that of a moth or butterfly, it is different in appearance.

There are two insects often mistaken for beetles—viz., the common earwig, and the black beetle, or clock of our kitchen. The cockroach, from being called "black beetle," is almost always supposed to be a beetle, and he had often been offered

them as such. It differs from beetles in the larva and pupa resembling the perfect insect, and in the pupa not being quiescent. The coleoptera, or beetles, are a very numerous order, the British number being between three and four thousand. They vary greatly in size, some of the large tropical beetles being more than four inches in length, while some of our native species are only 1-48th of an inch. They are of all colours and all shapes, and they are to be found everywhere and at all times of the year. The last fact is of great advantage to the coleopterist, as he can pursue his studies in the winter just as well as in the summer. Our native coleoptera may be classed under four general heads—adephaga, clavicorina, aeteromera, and rhyncophora. In Ireland, as far as our knowledge goes at present, we have a good many of the species belonging to this section which are given in the British list, and he felt sure that further search will bring up the numbers on our list to very near the total. At present there are about 445 species on the list, of which we can claim about 246.

Probably the most interesting of the land beetles is Pelophila borealis. That beetle, which is of a handsome bronze colour, was first recorded as British by Mr. Halliday from specimens taken on the shore of Lough Neagh by Mr. Robert Templeton. It does not occur in England or in Scotland. He has taken it in great numbers at Lough Neagh, at Lowry's Lough, near Armagh, and at Loughgill. Mr. Kane has taken it in Sligo, and it has been recorded from Killarney. Another beetle of this family to which he would like to draw their attention is a very small species called Dychirinos obscurus. Mr. Halliday has recorded that insect as having been taken at Lough Neagh; but Canon Fowler, in his work on the coleoptera of the British Islands, remarks—"I can find no trace of an authentic British specimen"—that is to say, that in all the collections he has had access to, he has not found a single specimen. Now, as the beetle was at Lough Neagh in Mr. Halliday's time, it is probably there still, so he recommended the matter to the Belfast entomologists.

The lecturer said he found very often that people were greatly astonished to hear of beetles living in water ; however, there are plenty of them, and they are very interesting in their habits. We must bear in mind that water-beetles are amphibious—they can swim about underneath, and can also walk on land or fly in the air. They are furnished with ample wings, and can fly a considerable distance. This amusement they indulge in mostly at night, though he has seen them flying in the bright sunshine, and that is one reason why persons who have fresh-water aquariums which are not covered are so apt to lose the beetles which are in the aquarium. It is related that a gentleman once found that the panes of glass in the roof of his green-house were broken without his being able to discover the cause. He watched very carefully to catch the culprit, and at last very early one summer morning, and soon after sunrise, he heard a crash on the glass, and on running up to the spot he found on the floor a large water-beetle. Of course he was very much surprised, but it was explained to him that the beetle must have mistaken the glass for water, and, shutting up its wings, dropped down from a height, and thus broke the pane.

Our Irish list contains a very good proportion of the water-beetles, and can boast of some which are very rare elsewhere.

Having dealt with other classes of insects, the lecturer said he trusted that the outline which he had endeavoured to place before them might have the effect of stimulating the curiosity of some of them, and making them take up the study of their native insects. He was especially anxious to get some one to take up the coleoptera, which is a most interesting order, and will well repay any trouble taken with them. The British list contains more than three thousand species, and of these 955 have been recorded as Irish. Mr. Halliday's list contains 528 species, and he has collected up to the present upwards of 700 species ; so we can see what hard work will do.

4th December, 1888.

PROFESSOR E. A. LETTS, PH.D., F.R.S.E., F.C.S.,
in the Chair.

JOHN BROWN, Esq., gave a Lecture on

SOAP BUBBLES.

THE lecture was illustrated by a number of experiments of soap bubbles in all shapes and forms.

Mr. BROWN said—The record of men of science who have devoted attention to the phenomena connected with soap bubbles is a pretty large one, and includes such men as the celebrated Robert Boyle (who, in 1663, examined and tried to account for the colours of the bubble), Sir Isaac Newton, Hooke, Young, Leidenfrost, Brewster, Draper, Sir William Thomson, and many others, as well as the great French physicist Plateau, whose researches have a sadly pathetic interest, since he was in the midst of them attacked by a disease which deprived him of sight, and it was only with "that inner eye which no calamity could darken," that he continued to investigate those beautiful phenomena as their colours and forms were described to him by his two faithful friends and assistants, Duprez and Donny.

The soap bubble is of interest, first, on account of the peculiarities of its own structure, its forms, its durability, and its colour; and, secondly, as an experimental tool for the investigation of other physical phenomena. The round form of a free bubble is due to the interaction of the air pressure inside it and the surface tension or elasticity of the liquid film. Both being equal all over the surface, it can be shown how no other figure could satisfy the conditions. The elasticity of the film is illus-

trated by hanging a bubble to a fixed wire ring, and hanging to the bubble a second ring with a small weight attached. On allowing the air to escape by breaking the film inside the fixed ring, the shrinking up of the film lifts the weight up to the upper ring. The colours of the bubble were for a long time a great puzzle to the early investigators, but since the discovery of the undulatory theory of light a satisfactory explanation of them has been found. They belong to a class of phenomena known as "colours of thin plates," and are caused by the "interference" of the light waves, reflected from the outer surface of the film with those reflected from the inner surface through the thickness of the film. The effect is to destroy some one colour in the light, leaving its complementary colour unbalanced, and therefore visibly tinting the otherwise white light. The matter is very clearly explained in Tyndall's charming book, "Lectures on Light." The colours are very well seen on a flat soap film attached to a ring of wire, or in a bubble partly filled with smoke, as was observed by Leidenfrost in the last century. He compares the resulting effect to a brilliant star, and then he moralises quaintly, "But all this glory vanishes the moment the bubble bursts ; the fetid smoke which escapes shows with what filth it was filled, and so offers us a striking picture of the gilded miseries of humanity." The well-known fact that two bubbles may be pressed together without coalescing is well illustrated by blowing one bubble inside another one hanging on a wire ring. The outer one must have either a drop of liquid or a wire ring hung to its under part, so as the thick under part of the inner one does not touch it—otherwise they will coalesce ; or if the inner one is filled with coal gas, it rises to the top of the outer one, which answers the same purpose. When the ring on which the outer one is fixed is very light and small, the whole combination rises in the air, the inner bubble representing the bag of gas, the outer one the net, and the ring the car of the miniature balloon. As an experimental tool, the bubble may be used to illustrate the diffusion of gases, a phenomenon examined and investigated

by Graham, who, like other great pioneers of science, attacked the most abstruse problems with the simplest possible apparatus. I think I have seen it stated that his entire laboratory for his diffusion experiments was contained on an old tea tray, and consisted of a few glass tubes, phials, and tobacco-pipe stems, and some plaster of Paris. After all, as in the case of the astronomical telescope, it is the man at the small end that is of most importance. If an air bubble be placed in ether vapour for a few seconds, the vapour diffuses into the bubble in sufficient quantity to cause it to explode with a considerable burst of flame when taken out and applied to a light. The magnetic qualities of gases are conveniently studied when these are enclosed in bubbles. Although outside the domain of bubbles proper, one or two illustrations may be given of the beautiful geometrical forms produced by Plateau on wire frames after immersion in soap solution. A cubical frame shows an arrangement of one rectangular film in the middle joined to the corners by twelve trapezoidal films. A triangular prism gives a set of nine plane films, and a helice of wire gives a very pretty screw-shaped film. A frame consisting of three rings fixed to a centre forms a circular trough of soap films, round which bubbles may be rolled as the ball on a roulette table. The greater part of these experiments have been devised by Mr. C. V. Boys, A.R.S.M., of South Kensington Science Schools, and are described in a recent number of the *Philosophical Magazine*, where also he gives the ingredients of the solution used in forming the bubbles. Some are from other authors, and others have been devised specially for this evening.

In conclusion, it may be asked—*Cui bono?* What is the good of it all? The seeker after knowledge asks no further result or reward than the pleasure of attaining definite knowledge. As the artist loves beauty, and will create beautiful forms for the mere love of his art, so the philosopher finds his keen pleasure in acquiring and setting in order new forms of knowledge. There is a keen delight in a new successful original experiment that belongs to few other enjoyments—in see-

ing for the first time that Nature has at length truly answered the question so often put in so many varied and doubtless imperfect forms before ; a delight enhanced by the feeling that, having asked aright, we have been answered truly, for—

> Nature never did betray
> The heart that loved her.

A fine specimen of the Himalayan vulture, recently presented to the Society by Surgeon-Major Crosse, and admirably set up by Mr. John Darragh, excited much interest.

8th January, 1889.

John Brown, Esq., in the Chair.

The Rev. Alexander Gordon, M.A., read a Paper on

NOTES OF SPANISH TRAVEL, 1888.

Prior to the delivery of the lecture,

Mr. Robert M. Young (Hon. Secretary) said Mr. Robert Lloyd Patterson had asked him to express his regret at being unable, owing to a previous engagement, to be present there that evening. Mr. Patterson, however, had, at his request, as he thought it might be of interest, sent up a few of the implements used in the seal and whale fisheries, which he had lately borrowed from Mr. David Bruce, of Dundee, for the purpose of illustrating a lecture, and he wished thus publicly to express his thanks to Mr. Bruce for his kindness in lending them.

Mr. Young then proceeded to show the implements to the audience. The first was an ordinary full-sized hand harpoon. A shaft about six feet long is fitted into a socket. The thickish rope spliced to the shank of the harpoon is called the fore gear, and to it the rope called the whale-line, or simply the line, is attached. No. 2 was a piece of whale line. To guard as far as possible against the danger to life and limb attendant on the lines fouling or getting entangled in running out, they are kept carefully coiled away in tubs. The harpoon, thus provided, is thrown by the hand, and struck into the body of the whale as soon as the boat has come within what the whalers call "darting distance." No. 3 was a gun harpoon. The line is attached to a ring, and the harpoon goes down to this into a short-barrelled, very strong gun, mounted on a swivel, from

which it is fired into the whale. This deadly implement is effective to a much greater distance than the old method. After the whale has become exhausted from the loss of blood and its exertions to escape, it permits a nearer approach, when it is killed by stabs with a lance, which, mounted on a socket, is thrust into a vital part, into its "life," as the whalers expressed it. No. 5 was a very interesting whaling trophy, a gun harpoon used by the Dundee whaler *Arctic*, and is one of four harpoons taken from a whale captured by that vessel a few years ago. This whale took eight hours to kill, but was well worth all the time and trouble, as it realised above £1,000. That may convey some idea of the enormous power of these huge animals. A whale has been known to run out six miles of line. No. 6 was a sailor's club or pickie, used for knocking seals when they are found on the ice. Some years ago it was no uncommon thing for a vessel engaged in the Newfoundland sealing to capture twenty-five to thirty, or sometimes even as many as forty, thousand young seals in one season. During the past season, 1888, four Dundee vessels took 66,617 seals at the Newfoundland sealing. The *Aurora* (Captain Fairweather) took 24,693, the *Esquimaux* (Captain Milne) took 22,894, the *Polynia* (Captain Guy) took 7,136, and the *Terra Nova* (Captain Fairweather) took 11,895—total 66,617. He was indebted to Mr. Patterson for the particulars, and he had derived them from Mr. Bruce and his friend, Mr. George Hatley, of Dundee.

The Rev. Mr. Gordon then proceeded with his lecture. He said he did not apologise for bringing them there that evening to hear a rambling report, because, if his remarks on the subject were not of that character, it would hardly be a lifelike and characteristic document; but he felt that he did owe an apology to a Society devoted to the study of Natural History and Philosophy, inasmuch as he was not blessed with that knowledge, or even an instinct for the acquirement of such

knowledge. He had observed that in the Bay of Biscay the waters of the sea were, to his eye, unusually blue, but he did not know the reason of that blue, and the rocks were red with a vivid redness, but why they were red, or what rocks they were, he knew not; and he had observed on a hill a sticky, ill-smelling plant, but why it stank, or why it stuck, or what plant it was, he could not tell them. Having made that confession of his utter incapacity to put subjects before a learned Society such as that to which [they were accustomed, he might state that there were two things, one of which he liked and one of which he disliked in making a tour, of which he meant to speak to them that evening. He liked to do a piece of business, and he did not like to be tied to a plan, and he strongly objected to be personally conducted.

He had a piece of business to do, mainly in the North of Spain, and there were one or two places he wished to identify, one or two books he wanted to discover, and two or three facts which he was anxious to verify. He was not going into any matters connected with those, but in the course of a ramble which had that general object, his eyes had been turned to what he had seen going on around him, and he had made certain notes. He had gone from Belfast right through to Orleans, a bright and pretty town, and from that he went to Toulouse, which had struck him as a place which exhibited one of the most forcible contrasts of the old world and the new. Toulouse is a very modern city, full of business, full of commerce and bustling crowds; but if one deviates but a little from the main stream of its commercial traffic, he gets into the middle ages without even having to take the trouble of a leap across a chasm; and, with its marvellous churches and crypts, the middle age appears still to retain its pristine life. Then from Toulouse, skirting the Pyrenees, he went to Louvre, and, having paid a little pilgrimage there, he proceeded across the Spanish frontier. He confessed it was with some degree of trepidation he felt himself for the first time on Spanish soil, for he had heard and read a good deal of rubbish about what was to be found in Spain. The

general strain of remark about Spain in guide-books is that it is a backward country. He could not confirm that remark, for, so far as his experience went, he would say it was rather a forward country, and a country which was now taking strides to put itself abreast of the age. He had been struck with the visible signs of the restoration of buildings, and that seemed to him to be an index to what was going on in other respects. Modern improvements are everywhere to be seen. The country is creeping on, and, though its pace may not be rapid, it certainly is not going backward. One curious result of its long delay behind and its present advance is that in Spanish civilization we miss certain intermediate stages. For example, we expect in most countries to find bells in use in inns. In Spain we may find them, but if we do they are always electric bells—those or none ;—the intermediate stage does not exist ; we pass at once from the time they had no bells at all to the time when they determined to put in those of the latest make. He had been favoured with good weather in his rambles through Spain ; and, as regarded the sanitary arrangements in Spanish inns, cleanliness, drainage, baths, and general accommodation, they are certainly better than are to be found in the South of France, and much better than are to be found, as a rule, in the North of Italy. The food is plentiful, of good quality, and savoury—he was speaking according to the measure of his own palate. He had been told to be on the look out for robbers, and he had been asked to take a revolver with him, but he told the person who spoke to him on that subject that a revolver was a rather heavy piece of furniture in a knapsack. He had simply taken a box of vesuvians with him, and found they were quite as rare in Spain as in Pennsylvania, and that they produced the same electrifying effect ; and one of them was equal to three cigars. Spain was, no doubt, in times past, and may be yet, infested with highwaymen, but, on the other hand, he had found the people generally to be singularly honest, and he had many instances of remarkable and scrupulous honesty in deal-

ing, and had never lost anything. Indeed, the scrupulous honesty of the people had struck him as one of their natural characteristics.

Spain is remarkable for its beggars, and there are two or three ways of dealing with them. There is no use in trying to ignore them, because they are not to be ignored, as they put themselves in evidence too strongly. It is best to appeal to their sense of humour, and then one may get off cheap enough.

A great drawback to Spanish travel is the bad traffic arrangements made by the railway companies; but they are not under Spanish management, but under French management. One or two of the companies are, however, getting to be under English management, which, he hoped, will effect a remedy in this respect. Excellent arrangements are made at the railway stations, where travellers can get served with a good meal at a reasonable cost, and if there is a long delay they can be provided with a sleeping apartment.

Spain is admirably supplied with maps and plans—maps of provinces, and plans of cities. The first great city he had visited was Bordeaux, whose great attraction is its cathedral, which is well known to everybody, and there he had an opportunity of seeing the portraits of its former bishops, which very few persons know anything about. His object was to see the portrait of a singular man and a remarkable character, known by the name of Solomon the Levite, who was succeeded by his son, and this was, he believed, the only instance in Christian history of one Hebrew succeeding another on the episcopal throne. With regard to Madrid, it was his opinion that it is the meanest capital in Europe. It has no cathedral, no good church, one good street, of which it is very proud, no fine shops, and no handsome cafés. But the one great glory of Madrid is its picture-gallery, and it is rather sad for a Britisher to think that the finest pictures in that room once belonged to our own Charles I. The Commonwealth, being short of funds, sold them to the Spanish Crown. He had

not a very high opinion of Spanish newspapers :—the one solitary item of English news which he discerned in any Spanish newspaper was an account of the Whitechapel murders ; and they are indebted to English newspapers for many of their facts. As to its political life, Spain has a large number of political parties—Conservatives, Liberals, Radicals, Liberal Conservatives, Revolutionists, Dynastic Liberals, and several others—each of which has its newspaper, but how they support them he knew not. In Spanish cathedrals music is the great feature. The organs are admirable, and even when they have bad organs they are well played. The practice of serenading with the guitar seems to be almost universal. Passing along the street, one sometimes comes upon groups of persons thus engaged, and sometimes upon a solitary cavalier playing on his guitar, evidently attracting the attention of some-one, presumably of the softer sex, who agitates the curtain of a window, but does not visibly countenance the proceedings. Mr. Gordon then gave a graphic description of the characteristics of a number of other Spanish towns which he had visited, the scenery which had come under his observation, and other peculiarities of the country.

Mr. W. H. Patterson gave some notes on a fine specimen of an ancient iron bell, probably Irish, found near Ledbury, Herefordshire. He identified the church where it was found with St. Fechan, the same name being found at Termonfechan, Ecclefechan, &c.

The Rev. Dr. Grainger and Mr. Robert Young, C.E., gave some information on the collection of drawings of such bells in Dr. William Frazer, M.R.I.A.'s possession.

5th February, 1889.

J. H. GREENHILL, Esq., Mus.Bac., in the Chair.

THOS. WORKMAN, Esq., J.P., read a Paper on

A VISIT TO SINGAPORE.

Mr. WORKMAN having prefaced his remarks with a comparison between an East India voyage in the time of James I. and the present time, said :—

It was early morning, and the sea golden, its mirror spread beneath the golden skies, when the vessel by which I sailed steamed round the northern end of Polo Penang towards its capital, Georgetown. We could not approach close to the shore, owing to the numerous fish-driving stations, which extend more than two miles from the land, the water being very shoal along the northern end of the island. These fishing stations are very common in the East wherever the water is shoal enough to permit them, and are made of two long converging fences of bamboos, stuck into the ground at the bottom of the sea, and then these uprights are intertwined with split bamboos, so that no fish can get through them. At the head of this huge trap, which is three or four hundred feet long, is placed the net on longer stakes. The fish are driven generally at night to the mouth of the trap, as they cannot get through the side walls up into the net. For liberty to erect one of these traps the fisherman has to purchase a license from Government, and as they are often placed far out at sea the owner has to keep a red light burning at night on its end. Penang is a mountainous island, the hills rising to the height of 2,700 feet, but Georgetown is placed on the eastern end of flat, low-lying

land which projects to the eastward of the mountains, and is nearly two miles from their base. At the north end of the harbour are the fort and the principal jetties. Steamers do not go alongside the quays, but anchor off from them and are discharged by lighters. At the harbour there is a deep depression in the sea bottom, in which there is eighteen fathoms of water, so that they are unable to make quays, the water being too deep. The principal object of interest to passing travellers is the waterfall, which is among the hills, about five miles from the town. The road up to it is very beautiful, being lined with various sorts of trees, principally cocoanuts, and twining among them was a beautiful purple convolvulus. In a watercourse at the side of the road I saw a number of curious little crawling crabs that live in holes which they make in the mud. They have one claw very much larger than the other, which they carry over their heads as if beckoning. I also saw in the same drain little fish that came out of the water and ran on the mud, like the little green fish one gets in the rock pools at the seaside, but of a lighter colour. The waterfall is in a very beautiful situation, in a cleft among rocks rising to a height of eighty feet or thereabouts. It is precipitated into a deep pool. The river, when low, as I saw it, passes under large boulders covered with vegetation, "trickling through soft velvet mosses, almost hid from sight." All the valley in which the fall and river are is retained by the Government as a public park. It consists of many acres, and is kept in beautiful order. As I was returning I passed a Hindoo funeral procession. The dead body was placed on a bier made of bamboos, over which was a canopy of white muslin ornamented with red and yellow tissue paper and the leaves of the banana. In front there were a number of men playing tomtoms, while another Hindoo danced in front of the bier. His contortions were very remarkable, and seemed utterly out of place. As the procession passed along men laid down their outer garment—a piece of calico about four yards long—for the bearers and others to tread on.

The Malays, who form a large portion of the inhabitants of Penang and the other parts of the Straits Settlements, are splendid divers, and it is said they can copper a vessel while she is floating, taking the sheet of copper down in their hands and the nails in their mouths. They are generally small, well-formed men, very active, and of gentle, quiet manners; but when roused they are exceedingly passionate.

After staying for a day or two at Penang I set out for Singapore, and the morning of the 5th February found me steaming down the Straits of Malacca, the shores of the golden Chersonese being dimly visible in the east. The straits are very shallow, and rather dangerous for the navigator. On board the steamer were a number of chitties who came on board at Penang, and who were bound to Singapore. Chittie is the name given to the Hindoo bankers, or money-lenders, like the Irish gombeen men. A chit is an I O U, or promise to pay, and much used in the East, as no one thinks of carrying money in his pockets, on account of its weight. From their appearance one would judge these chitties to be more likely to be beggars than money-lenders, as their clothing is a piece of calico about four yards long, and which once was white, probably costing eighteenpence when new. They spent the day principally in playing cards. The game I knew not, but, if report spoke truly of their business, I would suggest, "beggar my neighbour." On board there was a large consignment of tin ingots, of about 50lbs. each, coming from the mines at Perak, on the mainland, and going to England *via* Penang and Singapore. These mines are very profitable now that the price of tin has gone up. On going on deck on the morning of the 6th February, I found we were just entering the new or western harbour of Singapore. It was most lovely. Sea and land "were glowing fresh and fair with the breath of morn and the soft sea air." One knew not which was the more beautiful—sea or land. The brilliant green wooding of the little islets came right down to the water's edge, for in this calm tropic the wind scarcely ever blows with

violence. Unfortunately the last war scare has not improved the summits of the islands; for, as we know, Singapore is one of our principal coaling stations, and it is considered necessary to fortify it strongly. A year or two ago, when it was thought Russia and France were about to declare war against England, a large Russian man-of-war hung about Singapore for a considerable time, to the great anxiety of the inhabitants, who had a very good idea that the moment war was declared she would begin to shell the town, and there was really nothing to prevent her reducing Singapore to ashes. Now this is impossible, for the surrounding islands are all cut into bastions, ravelins, scarpments and counter-scarpments, and all the paraphernalia of defensive warfare, to the great injury of their natural beauty.

Having given a description of the two miles of road between the landing-stage and the town, the lecturer continued :—On leaving the steamer is a not very high hill, covered to the summit with palms and other tropical trees and plants. The cocoanut is the principal of these; but there are a few specimens of a curious palm called "the traveller's tree." These spread out their fans to catch the breezy air in a most remarkable way—all the leaves being in one plane on each side of the stem. It is very appropriately called "the traveller's tree," for in the driest of seasons one has only to cut into the base of the leaf stalk, which is seven feet long, to obtain a copious supply of pellucid water. The leaf stalk is hollow from end to end, and the palm keeps it always filled up with water—probably as a source of nourishment for itself. It is not indigenous to Singapore, but is a native of Madagascar. Along part of the road the Malays had built their houses out on the water on piles, just as the ancient Irish had done at Lough Mourne, elsewhere connecting them with the solid ground by piled causeways. Not far from this, where the ground rises, we passed some Chinese graves, which were not very interesting, being without any attempt at ornament—just a low wall, oval in shape, rising from six inches at the outer ends to two feet in the middle, where the headstone is placed. The name of the

occupant, and possibly a sort of epitaph, or maybe a wise saying of Confucius or Budda, is cut in a single perpendicular line down this stone, which is usually of granite, the other parts of the wall being brick. I used to have the idea that good Chinese considered it imperative to be buried in their native land, but that is certainly not the case in Singapore, where the Chinese burying places have become a grave question for the authorities, and one over which they are racking their brains to get a workable solution.

Many of the streets, squares, and buildings in Singapore are called Raffles, and not without reason, for the town of Singapore owes its very existence to the ability and wisdom of its first governor, Sir Thomas Stamford Raffles, who was made Governor of Java when it was taken from the Dutch in 1811, but had to leave when it was restored to them at the end of the French war. Before leaving the East, he, seeing the desirability of the English nation having a port convenient to the Straits of Malacca for the protection of their rapidly-growing shipping trade, made arrangements with the Sultan of Jahors to take over the island of Singapore. The result has fulfilled all the expectations of this able and far-seeing politician, who began life as a clerk without influence in the East India Company's service. Singapore is a free port, and the whole government, municipal or otherwise, is carried on by the money raised by licensing the sale of opium and spirits. If any British subject, dissatisfied with his rates or taxes, would only betake himself to the flourishing town of Singapore, he would find himself in a place where, if he only kept himself from spirits and opium, he would know nothing whatever of the taxgatherer, while he would have free libraries, museums and gardens. If the authorities in Singapore were also allowed to licence gambling, I understand they could double the revenue ; but that would not be permitted by the British Government.

Having given a graphic description of the country generally, and of how he spent his time in Singapore, along with

Mr. Davidson, a native of County Down, he continued:—Many of the people have neither vegetables nor fruit, but live almost entirely on sago and little fish. The coffee tree naturally grows to a considerable height—from 20 to 30 feet. The Liberian coffee is not liable to the coffee disease which has been so disastrous in Ceylon, where, owing to its destructive effects, coffee has almost ceased to be grown. The disease is a sort of fungus which grows on the leaves, giving them a motley appearance like a variegated laurel. Monkeys, of which there are two species, abound in the jungle round Mr. Davidson's plantation, which I visited, and are very destructive to the coffee. Pepper is also raised in quantity on Mr. Davidson's plantation, but the plant is quite different from the one grown in the South of Europe, though the pepper tastes exactly the same, except that this is more pungent. The jungle round the plantation swarms with tigers, and I was shown the tracks of one not five hundred yards from Mr. Davidson's house.

MAMMOTH'S TOOTH RECENTLY FOUND IN THE DRIFT GRAVELS AT LARNE HARBOUR.

Dr. John Moran, H.M.I.S., then exhibited a mammoth's tooth recently found by him in the drift gravels at Larne Harbour. He said:—In reference to the molar tooth of the *elephas primigenius*, or mammoth, recently found by me in the gravels at Larne Harbour, I beg to make a few remarks. The following is the succession of the beds in ascending order:—1, older boulder clay; 2, coarse sand, with particularly rolled stones (3 to 4 feet thick); 3, coarse gravel, with rolled stones (6 to 10 feet thick); 4, a layer of silt, or rather coarse laminated clay (3 to 5 inches); 5, a second layer of coarse gravel, with rolled stones (18 inches to 2 feet); 6, dark surface layer (18 inches), containing innumerable neolithic implements of a very rude

type. No. 1 is the lower boulder clay or till of the period of intense glacial conditions. Nos. 2, 3, 4, and 5 have, I believe, resulted from the denudation caused by vast floods flowing from the end of the glacier that filled the valley of the Larne or Inver River towards the close of the last glacial period. As the climate became gradually more temperate, the glacier retreated upwards towards the higher grounds, and the summer sun and the great rains of that period brought down, first the sand which had accumulated in the estuary of the ancient interglacial river, and next, the coarse gravel and stones which form the No. 3 bed. When the end of the glacier had melted on higher ground, the fall of the torrent would tend to bring down coarser material as in beds Nos. 3 and 5. How does this account for the intervening layer (No. 4) of laminated clay? I traced the formation upwards, and I found the very beds of newer boulder clay (a little above the town of Larne) from whose denudation this layer must have been derived. The boulder clay at this place had been protected from the erosive action of the large ice sheet in the narrow gorge where its remains lie at the present day. It was denuded when the glacier had retreated to higher ground and had exposed it to the action of the summer floods. I beg to call particular attention to this layer of laminated clay, as it is in it I found the mammoth's tooth. The bed of newer boulder clay, from which it has been derived, forms high banks where the course of the present insignificant stream is most rapid. In this upper boulder clay the mammoth's tooth must have been protected from the grinding action of the last ice sheet and subsequent glacier. Both were swept down together as the glacier had retreated thus far up the valley. After this boulder clay had been partially denuded, and dropped as laminated clay on the lower grounds (with its mammalian relics), the glacier still further retreated to higher grounds, and, with milder climactic conditions, the floods, becoming more intense, brought down another layer (18 inches) of very coarse gravel with large rolled stones. To account for the larger stones in the sand and gravel—some as much as 10 inches in

diameter—I would suggest the action of river ice formed each winter below the end of the glacier. As the heat of summer approached, the floods from the surface and from the end of the glacier would break up the river ice and force it along, together with any stones embedded therein. After these strange Old World scenes had passed away, the river gradually retreated to its present channel. The land was subsequently submerged to the depth of 30 or 40 feet, and the sea overflowed the gravels. This is evident from the fact that marine shells and beach deposits cap the gravels on the portion nearest to the seashore. This was the period of the raised beaches at Cultra, Ballyholme, and Kilroot. The next stage in this strange scene is the advent of neolithic man. The country being covered with forests, he found it convenient to establish himself on the ancient gravels long after the sea had retired. His remains form a layer of 18 inches, consisting of rude flint implements of neolithic type, lying just as they fell. This upper layer is not stratified, and therefore not due to the action of running water. The line of demarcation between this layer and the palæolithic gravels beneath is very distinct. In describing the beds, I refer to the portion of the gravels at the right hand side of the harbour, as one enters from the steamer. These are being removed for ballast, and the beds can be most distinctly traced, as the cutting is nearly vertical. On the western side of the road the sections are not so well exposed; but the corresponding layers can be distinctly traced. Towards this western side—approaching nearer to the modern river—there seem to be more numerous evidences of intervening beds of laminated clay, as might have been expected from the greater force of river action towards the centre of erosion.

A living octopus was shown and described by Mr. R. Lloyd Praeger.

26th February, 1889.

J. H. Greenhill, Esq., Mus. Bac., in the Chair.

Dr. MacCormac gave a Lecture on

MAN'S FOOD AND DIETETICS.

Dr. MacCormac said—The want of a little scientific knowledge of the composition of food and its action on the system often leads to interference with the digestive and nutritive functions, and, of necessity, to ill-health, disease, and death. If apology, therefore, were necessary for drawing attention to the subject he had taken for his lecture, this fact might, he thought, be deemed a sufficient one. He proposed to deal with the subject under five heads—first, the chemical composition of man and his food; secondly, the origin of food; thirdly, the alimentary production of the animal and vegetable kingdoms; fourthly, beverages; fifthly, principles of dietetics.

After describing at length the chemical composition of the human body, the lecturer proceeded to say that, the human frame being largely composed of nitrogen, it is necessary in order to complete its structure, and to repair the daily waste, that heavy drafts must be made upon nature's bank of nitrogen. Her stores are found in abundance in flesh, milk, and eggs, and in smaller quantities in fruits and vegetables; and to these man goes that he may not perish of exhaustion or pinching poverty. But heat has also to be created in more or less abundant quantities, according to the temperature by which he is surrounded. In a northern climate like our own, a considerable proportion of the food taken is thus consumed in keeping up this animal heat. The

carbon—the principal element of vegetable and fatty substances—combines with the oxygen introduced into the system by inspiration, forms carbon dioxide, and evolves heat. Thus we see that the nitrogenous element in food, represented by flesh or animal substances, is required chiefly to perfect the tissues of the body, and to repair their waste; while the carbonaceous element—represented by vegetable articles of diet, and by fats and oils—is absolutely necessary as fuel to support the silent combination ever at work in the system, and to which is mainly due the generation of vital heat. The production of the muscular power of animals is not so much dependent on the assimilation of nitrogenous food as upon the slow combustion of carbonaceous food. According to this view, the formation of heat by the combustion of carbon, and the final assimilation and nutrition processes generally, are attended with the development of force, of which the muscles are the instruments, not the producers. Since the slow combustion of carbonaceous food in the process of nutrition is attended with the development not only of heat but also of force, it consequently appears that more power or force is to be obtained from fat than from meat or muscular tissue. The labourer in the fields when starting for his daily toil, with reason, then, and not alone from motives of economy, provides himself with bread and the fat of bacon. Similarly the hunter, when about to be exposed to toilsome expeditions, supplies himself with heat and force-producing fat.

After some observations on the chemical origin of food, the lecturer proceeded to the third branch of his subject, dealing *seriatim* with the various food products of the animal and vegetable kingdom and their relative value. With regard to flesh food, experience teaches us that, although the flesh of young animals is more tender than that of old, it is, nevertheless, more resistant to the digestive powers. Veal and lamb, for instance, tax the weak stomach more than beef and mutton. The tissues of young animals, too, are more gelatinous, less stimulating, and of less nutritive value than are the more matured. Again, there is

generally recognised a particular season when certain kinds of flesh food ought not to be eaten. Beef and mutton, although never really out of season, are in the highest state of perfection in the autumn and early winter, after the animals have enjoyed abundant pasturage. Pork should never be eaten in the summer, and venison only in the autumn and winter. The practice of draining the blood from animals, in slaughtering them for food, involves a waste of nutritive material, and would be condemned but for certain real or fancied advantages—the meat is improved in flavour, keeps longer, and looks better. On this point it is interesting to notice the strictness of the Mosaic law as to the absolute necessity of the removal of the blood. Jews, as a matter of religion, will not eat the flesh of any animal not slaughtered by one of their own race. They consider their meat far superior to ours, and it is eaten by preference by some Christians. Mutton, though slightly less nutritious, is generally considered to be more easily digestive than beef. There are, however, peculiar idiosyncracies with regard to food. There is a record of a person to whom mutton acted as a stomachic poison, causing nausea, vomiting, and internal pains ; and this was not a matter of caprice, for the meat was frequently disguised and given to him with the same result. Pork is the most difficult of digestion of any animal food, as venison is one of the most digestible.

Roughly speaking, 20 per cent. of the whole weight of the carcase of an animal, as dressed for food, is bone. Bones contain a considerable amount both of nitrogenous and fatty matter, and to extract it they should be broken up into small fragments and boiled in a digester or high pressure boiler. Some authorities state that three pounds of bones contain as much carbon as one pound of meat, and that seven pounds of bones contain in nitrogen the equivalent of one pound of meat.

One of the most important points to be noticed is that meat should be eaten only when perfectly wholesome. A few simple rules on this head may be useful. Meat is unwholesome if it is of either a pale pink or a deep purple colour. The former is a sign

of disease, the latter has died with the blood in it, or suffered from acute pain. It is wholesome if it has a mottled appearance, from the ramification of little veins of fat among the muscles. It is wholesome if it is firm and elastic to the touch, for bad meat is wet and flabby. It should have little or no odour, and that not of a disagreeable character. Sufficient heat destroys parasite life in meat if it exists ; hence the paramount necessity of raising the temperature in cooking to above this point. Many instances have been recorded where fatal results have been caused by eating the flesh of an animal infected by disease ; and Dr. Livingstone speaks of having met with cases of malignant carbuncle produced by this cause.

Next to mammals, birds are of the greatest importance as food. So far as is known, there is no bird, or part of a bird, or egg of a bird, which may not safely be used for food. However, some birds are doubtless rendered poisonous by food they have eaten. Thus American pheasants and partridges have often been found to possess poisonous qualities. Game, as distinguished from poultry and wild fowl, is very appetising and strengthening ; but invalids, or those of weak digestion, should eat only the breast.

After referring to the different kinds of fish, cereals, vegetables, fruits, &c., the lecturer went on to deal with fluid foods and beverages. He impressed the necessity of purity in water and other drinks consumed. If a plain and wholesome liquor be drunk, the error of taking too much is not likely to be committed. Some people hold the erroneous idea that the amount of liquor taken at meals should be considerably restricted in order to avoid any excessive dilution of the gastric juice or digestive fluid of the stomach. Mischief is thus frequently occasioned, particularly in the higher ranks of society, by taking small quantities of fluid at meals, and those of a more or less strongly alcoholic character. Tea, taken in moderate quantities, exerts an exhilarating influence and restorative action without the ill effects of alcohol. Coffee and cocoa are also useful and wholesome beverages. Alcoholic beverages, when consumed in

moderate quantities, appear to encourage the appetite and promote digestion ; but taken excessively, they destroy the appetite, and impair the digestive powers. Alcohol he conceived to be useful when given in medicinal doses—for example, after an acute illness of two or three weeks, when emaciation is often extreme, and more especially when digestion is interfered with. In continued fevers, too, it is often absolutely necessary to give wine or other alcoholic beverages, in order to afford to the organisation the elements for heat generation by organic combustion, and to retard the process of destructive loss of tissue. But there is no denying the fact that the habitual use of stimulants to any extent produces premature decay and early death.

Mr. Robert Young, C.E., then gave a description of some geological observations made by him in connection with the excavations for the Greencastle Waterworks, and exhibited a number of specimens.

5th March, 1889.

W. H. Patterson, Esq., M.R.I.A., in the Chair.

S. F. Milligan, Esq., M.R.I.A., gave a Lecture on

THE SEPULCHRAL STRUCTURES AND BURIAL CUSTOMS OF ANCIENT IRELAND.

Following the same line of inquiry which I have pursued on several previous occasions, I purpose referring to our ancient sepulchral monuments, as a further illustration of the architecture, civilisation, and modes of thought of the people of Erin in ancient times. I will also briefly refer to some customs relating to the burial of the dead in the olden time. We do not spend as much thought and labour on our sepulchres as our Pagan ancestors did. They spent more time and labour in the erection and decoration of their tombs than they did on their dwelling-places. In some of the more remote districts of Ireland old legends are still related and many customs practised that are unknown to the dwellers in towns and cities, as well as to many of the people living in districts less remote. The desire for a large funeral amongst the relatives of the deceased, and to have a monument of stone erected, has been transmitted to us by our predecessors who raised the pillar stones and cromlechs, and carved thereon their Ogham inscriptions. The desire to live after death in the memory of our fellows is a laudable one, and has been an incentive to many a noble action and philanthropic deed. Schlegel, in his "History of Literature," says funeral customs are testimonies of the modes of thinking and the degree of civilisation of a people. He says a nation without traditions, tombs, and

poetry, is sure to be plunged in barbarism. And, further, the prevailing modes of treating the dead amongst different nations are not only worthy of great consideration as testimonies of their modes of thinking and degrees of civilisation ; over and above all this, they are in general very intimately connected with their secret impressions and religious feelings.

The sepulchres, burial customs, and modes of interment of different races vary as widely as their dwelling-places and customs during life. The Greeks from a remote period used cremation for disposing of the remains of the departed. They supposed the spirit of life ascended to heaven in purity amongst the flames, whilst the earthy part remained amongst the ashes as a memorial of the dead. We shall find on further investigation that many of the social customs of the Greeks in the Homeric period were very similar to what prevailed in Erin in her heroic age. If time permitted, we might briefly refer to some of the customs of ancient nations in the disposal of their dead, as they are very interesting, but a few will suffice. An Eastern custom amongst the followers of Zoroaster still prevails in Thibet. From a mistaken idea that the pure elements of earth or fire would be contaminated by being made the instruments of dissolution, the corpse is laid upon a platform, and there left a prey to wolves and vultures. The Egyptians embalmed the bodies of the departed ; so did the Peruvians. The bodies of the Incas were embalmed, and placed in a vault with their predecessors. On special occasions a mummy Inca, dressed as in life, with magnificent robes, was placed in the audience chamber of the reigning monarch, when the dread power exerted during life was supposed to influence any unruly chieftains present, and to awe them into submission. Many of the Egyptian tombs near Thebes are hewn high up in the rocky cliffs, above the Nile's highest water-mark, and their walls and ceilings are decorated with paintings in brilliant hues, illustrating the manners and domestic life of the former occupiers of the land, so that in the present day we can form

a fair idea of the manners and customs of the Egyptians from those histories pictured on their tombs. They believed that after a lapse of many thousands of years their souls would come to reinhabit their bodies if the latter were preserved entire. Herodotus relates of them that at their principal feasts, when they began to taste the wine after supper, a person appointed to that end carried about in a coffin the image of a dead man carved in wood, and representing the original in colour and shape, and pronounced these words to everyone distinctly:—"Look upon this, then drink and rejoice, for thou shalt be as this is."

In Irish tombs pictures are not found, as in the Egyptian, though they are ornamented with symbolic carvings, the key to all of which has not been clearly defined. Occasionally there are found in tombs implements and ornaments which enable us to form some idea of the civilisation that had been attained to at the period of the interment. Implements of bone, rough flint, and unpolished stone weapons are found in graves of the earliest period. Polished flints, stones, and beads are found in tombs of a more recent date, whilst bronze weapons and ornaments are discovered in tombs of a still later period. Bronze weapons and ornaments also show various stages of development, from the plain bronze celt to the beautifully-finished socketed spear or sword, inlaid with gold or precious stones. A great development in art is observable from the rudely-carved bone ornaments to the torques and fibulæ, in bronze, silver, and gold, decorated with those charming interlacing patterns, so minutely carved as to require a glass of some power to detect all the delicate tracery with which they are so profusely embellished. From an examination and comparison of implements and ornaments found in the tombs, we may form a fair estimate of the civilisation that was contemporary with these objects. The antiquarians of future ages, however, will not derive much information from the tombs of the present time. The brass plates and mountings of coffins

are the only metallic objects which, if they survive, would go to illustrate the civilisation of this age. With the exception of granite, most of our monumental stones are put up more with an eye to present appearance than to durability ; consequently, future antiquarians will not have the same advantages when investigating this age as we have in reference to our ancestors.

Mr. James Ferguson, in his work, "Rude Stone Monuments," after referring to Carrowmore, County Sligo, and Glencolumbkill, County Donegal, speaks rather disparagingly of the remaining isolated cromlechs of Ireland. He says—"It is extremely difficult to write anything that will be at all satisfactory regarding the few standing solitary dolmens of Ireland." He says, further, if all those which are described in books or journals of learned societies were marked on a map, the conclusion would be that the most of them are found on the east coast, a dozen or so in Waterford, as many in Dublin and Meath, and an equal number in County Down. He concludes his description of Irish sepulchral monuments by saying that there may be other rude monuments in Ireland besides those described, but they cannot be very numerous or very important, or they would hardly have escaped notice. It is to be regretted that such statements should go forth uncontradicted. Only four counties in Ireland up to the present time have been systematically explored and described. The first (County Dublin) was completed many years ago. Mr. Wm. Gray was next in the field, having described and figured twenty-four cromlechs in Antrim and Down. County Sligo, the last thus described, has just been completed in the columns of "The Journal of the Royal Historical and Archæological Association of Ireland," by Colonel Wood Martin, the honorary secretary. The number of sepulchral monuments figured in the journal for County Sligo is about one hundred. With the exception of these four counties, Ireland, from an antiquarian point of view, has yet to be systematically explored and described. County Donegal is very rich in those remains of past ages ; indeed, with the ex-

ception of Carrowmore, there is no such collection of cromlechs in the United Kingdom as in the districts of Malinmore and Glencolumbkille, on the property of Messrs. John and James Musgrave. After Carnac, in Brittany, and Carrowmore, in Sligo, this district in Donegal has the third finest collection of cromlechs in Europe, numbering about thirty in all. Messrs. Musgrave have recently vested these monuments in charge of the Government, under Sir John Lubbock's Ancient Monuments Act, and they will be taken charge of in the future by the Board of Works. This district, in addition to these ancient monuments, has great attractions for the ordinary tourists. Words do not convey any idea of the impression made on the mind on obtaining a view from the sea of the stupendous cliffs of Slieve Liag, 2,000 feet in perpendicular height ; or of the wild and rugged scenery of the mountain passes which the traveller may explore.

There are a great many sepulchral monuments and inscribed stones scattered over County Donegal. One of the finest stone circles in Ireland is situated on a hill within two miles of Raphoe, at a place called the Topps. There is in this circle a very curious stone covered with cup marking. There is another fine circle between Carndonagh and Culdaff, as well as a huge kistvaen. In County Tyrone there are a great many sepulchral monuments. One of the most notable is on the hill of Knockmany, near Clogher. In another district of Tyrone, adjoining the towns of Castlederg, Newtownstewart, and Plumbridge, I noted nine cromlechs, some of them cup marked, beside pillar stones, and cairns, none of which have been heretofore described. In other districts of Tyrone there are cromlechs, so that when it is systematically gone over, Tyrone will be found to contain a great many interesting relics of the past. If we accept Schlegel's maxim, we may assume that a country so rich in tombs and traditions, with its heroic history embalmed in verse, has had a civilisation equally remote.

Amongst the ancient sepulchral monuments in Ireland are the cairns, cromlechs, kistvaens, giants' graves, stone circles, and pillar stones, which are found in the country singly and in

groups. In the ancient book of "The Cemeteries" eight great burying-places are named where the kings and nobles of the various provinces were interred. Besides these, there are several other cemeteries of great importance, but not entitled to rank with those eight. Of the first rank Brugh-na-Boinne and Relig-na-ree are well known. Tailtin was another of the great cemeteries, but some doubt exists as to the exact locality where it was situated. The great cemetery of Brugh is situated on the northern side of the Boyne, between Slane and Netterville, for a distance of three miles long, and one mile broad. There are three great mounds, beside many minor ones, in Brugh. The three principal are New Grange, Dowth, and Nowth. The first two are chambered, aud have been thoroughly explored and described. Nowth still remains unexplored, owing to the unwillingness of the proprietor to permit its being opened. Sir Wm. Wyld, in his "Beauties of the Boyne and Blackwater," says of New Grange that there are some 180,000 tons weight of stones in the mound of New Grange. It covers nearly two acres; it is 400 paces in circumference, and 80 feet higher than the natural surface of the hill. A few yards from the outer circle of the mound there appears to have stood originally a circle of enormous detached blocks of stone, placed at intervals of about ten yards from each other. Ten of these still stand on the south-eastern side. Dr. Wyld concludes his description of New Grange as follows:—"This stupendous relic of ancient Pagan times, probably one of the oldest Celtic monuments in the world, which has elicited the wonder and called forth the admiration of all who have visited it, and has engaged the attention of nearly every distinguished antiquary not only in the British Isles but of Europe generally, which, though little known to our countrymen, has attracted thither pilgrims from every land."

The lecturer proceeded to show a series of photographic views of the exterior of New Grange, the remains of the stone circle, the entrance to the mound, a ground plan of the mound, showing the arrangement of the stones in the entrance passage

and cruciform chamber, the sarcophagus in the eastern chamber, and the spirals, volutes, zigzags, and other symbolic carvings on the stones. The entrance passage through the longer axis of the cross is 63 feet, formed of huge flags set on end, and roofed across with others equally large. One of the roofing stones is 17 feet long by 16 feet broad. The average width of the passage is about three feet, and the average height about six feet. Close to the entrance some of the side stones have fallen in, and the principal passage is here very narrow, so that to enter it one has to creep in on all fours. The height of the chamber is nineteen feet six inches. From the entrance to the hall of the chamber opposite measures eighteen feet, and between the extremities of the right and left crypts twenty-two feet. The Mound of Dowth was next described as 300 feet in diameter, and 45 feet in height above the level of the ground. The cruciform chamber was described, together with another chamber quite recently discovered. In Dowth as in New Grange the stones are covered with symbolic carvings, and there is a basin-shaped stone, or sarcophagus, larger than any in New Grange, being five feet in its longest diameter.

Another of the great Pagan cemeteries of ancient Ireland was Tailtin, where the Ultonian or Ulster kings were buried. Up to about twenty-five years ago it was believed that a place called Telltown, situated about midway between Navan and Kells, was the ancient Tailtin. The absence of sepulchral monuments at Telltown and the discoveries of Mr. Eugene Conwell have led many archæologists to look elsewhere for this ancient burial place. About twelve miles from Telltown there is a range of hills, known as the Lough Crew Hills, on which Mr. Conwell twenty-five years ago discovered some thirty cairns, several of which contained chambers with sculptured carvings somewhat like those at New Grange. Mr. James Ferguson, already referred to, visited this district with Mr. Conwell, and was impressed very strongly with the idea that these cairns and chambered tumuli formed the ancient Pagan cemetery, so famous in Irish history. Mr. Ferguson and Mr. Conwell have made out a very

strong case to support this theory. The late president of the Royal Irish Academy, Sir Samuel Ferguson, contributed a paper on the transactions of that society, in which he freely criticised the arguments for and against the theory of Mr. Conwell. The lecturer proceeded to describe and show views of the cairns and chambers on the Slieve na Calliagh Hills, near Lough Crew.

An ænach or fair was held at Tailtin from B.C. 1200 to the eleventh century of our era. These ænachs or fairs originated in funeral feasts and games, given in honour of deceased kings and chiefs, and were celebrated annually or triennially afterwards to perpetuate the memory of the person for whom they were originally instituted. The fair of Tailtin commenced in the middle of July, and lasted about three weeks. There were sports, and contests similar to those held at the Olympic Games, as wrestling, boxing, running, also horse and chariot races. The people were entertained with shows and rude theatrical exhibitions. The king and chiefs sat on the burial mounds as judges, and afterwards distributed the prizes to the victors. These fairs were attended by the men and women of a province, both married and single, who pitched their tents or booths, in which to live during the period of the fair. The laws that regulated them were strictly observed. The women had separate quarters assigned them during the fair, from which the opposite sex were prohibited, the penalty for violating the rule being death. The last great fair of Tailtin was held in the reign of Roderick O'Connor, the last monarch of Ireland. The annals of the Four Masters record :—" On this occasion the fair of Tailtin was celebrated by the King of Ireland and the people of Leath Chuin (northern half of Ireland), and their horses and their cavalry were spread out on the space extending from Mullaghaidi to Mullagh Tailtin." A description of the fair was given, including the betrothal of the young men and maidens, which was one of the events of the fair looked forward to with the greatest interest. The Cemetery of Relig-na-Ree, the burial place of the kings of Connaught, was next described, and a view shown of the tomb of Dathi, the last Pagan monarch of

Ireland. The other celebrated cemeteries were referred to—Ænach Ailbhe, Ænach Culi, Ænach Colmain, and Teamhair Erann. Killeen Cormac was referred to, and a photograph shown of it. Here the first Ogham stone with a bilingual inscription was found.

There were three principal modes of burying the dead in Pagan times. First, cremation. After the body had been burned on a funeral pile, the calcined bones and ashes were collected, and placed in an urn of either stone or baked clay. This urn was deposited in a small stone cist or chamber, formed in the ground by flagstones set on end, and covered across the top with another flag, and earth piled over all. Second, simple burial or interment in the earth. A grave large enough to hold the body was dug. The sides of the grave were protected by stones placed on edge or a wall built of dry masonry, and covered across the top by one or more stones. The third mode was rather exceptional ; the body, armed as in life, was placed in a standing or sitting position on the ground, or in a chamber or cist, over which a cairn of stones or earth was heaped. Cremation was referred to, and cemeteries exclusively devoted to bodies which had been cremated were mentioned, as at Ballonhill, in County Carlow, and Drumnakilly, near Omagh. A photo was shown of an urn found in the latter place, once in Mr. Milligan's possession, but which had unfortunately got broken. It is said to be one of the finest ever found in Ireland.

With one exception, there is no mention of cremation in any of our ancient manuscripts, though urns containing calcined human bones have been found in great numbers in every part of Ireland. A report of the recent find of an urn near the Belfast Waterworks, at Woodburn, was given. It was from a description supplied by Mr. George Reilly. The urn was found in a stone cist, covered by a large flagstone. It was placed mouth upwards, and contained ashes and calcined bones, which were shown. The customs connected with cremation in ancient Greece were referred to, and from the fact that many of the other social customs were so similar to the

Irish, it was inferred that cremation in Ireland was attended with similar ceremonies. The burial of Patroclus was referred to as an illustration of the ancient ceremonial, the oldest record of cremation extant. The mode of burial varied in Ireland at different periods. One of the most ancient was to make a hollow pit in the ground, in which the body was laid, rolled in a garment called a rochull. Dr. Keating describes it thus :—They used to make a fort in the earth corresponding in length and breadth with the corpse. They then deposited the corpse therein, with the soles of the feet turned to the east, and the crown of the head to the west, and put stones over it, forming what was called a leacht. Dr. Sullivan says the word "leacht" seems to have been a general term applied to stone sepulchral monuments, consisting either of unfashioned stones of every size, piled up over a simple grave, or over an Indeith Cloich, or stone chamber, or of a number of large upright flags, upon which was placed a great block of stone. The latter kind of leacht is the monument popularly known as a cromlech. A simple flag marking a grave was called a leac. Dr. Sullivan says further, when a number of persons were buried beside each other, their leaca were placed in a circle around their graves. Similar circles of leaca, or upright flags, were put around the leachts, formed of piles of stones. This explains the origin of stone circles, and also of the standing stones placed around mounds and cairns similar to those shown around New Grange. Those who died of the plague were buried in what was called a Mur. These were well known, and could not be opened for several years. The Mur was constructed of dry masonry not less than two feet high, which covered the whole grave, and where stones could not be obtained a similar block was built of square sods over the grave. So late as 1847 it is said some of those who died of famine-fever in Ireland had their graves covered with a Mur, as an indication that it should not be opened for a long period. The construction of cairns, kistvaens, cromlechs, and other ancient monuments were minutely described, and a great many photographic views of the finest

examples were shown. These included some, shown for the first time, which had been brought under the notice of archæologists by Mr. Milligan. Our modern sepulchral monuments are copies of the Pagan tombs on a small scale. The flat covering stone, supported by four uprights, is a cromlech. The headstone is copied from the ancient Dallan, or pillar stone, the Ogham inscription being replaced by one more intelligible to the people of to-day. The enclosed cist is a copy of the more ancient kistvaen. Even the cross is not a modern emblem, as it was known in Pagan times, in both the Old World and the New. Small incised crosses as monuments of the dead were shown, as well as the beautifully-carved flags which covered the tombs of the Mac Swyne of Banagh, and the Mac Swyne of Doe. The Caione, or funeral chorus of the dead, was referred to, and the ceremonies attending it, both in ancient and modern times, were described. Several translations from the Irish of these death-songs were read, showing deep pathos and a true poetic spirit. Wakes and funerals are still largely attended in country districts, but they differ considerably from those described by Carleton. We hope the change is in the right direction, and that it will tend to the welfare and social improvement of the people. We may study the bent and genius of our race through her ancient monuments, her works of art, and her code of laws. We look back at the various phases of a past civilisation as embodied in these memorials with some degree of pride, and to the future with a hope that brighter days are in store for our country than any experienced in the past.

A fine collection of nests and eggs of marine birds, photographed by Mr. Green, of Berwick-on-Tweed, was shown.

March 19th, 1889.

Allan P. Swan, Esq., read a Paper on

THE FUNGUS OF SALMON DISEASE: ITS LIFE AND FUNCTION.

It is only about twelve years since the first outbreak of what has since been known as the "Salmon Disease," or "Salmon fungus," occurred in the rivers Nith and Esk, that flow into the Solway Firth. The disease rapidly spread to several adjoining rivers, and in the spring of 1879 it broke out with great virulence in the Tweed, and in little more than another year had extended to the rivers Annan, Eden, Cree, and Dee, all running into the Solway Firth; to the Derwent in Cumberland, and the Lune in Lancashire. It had also spread northwards to the rivers Doon and Ayr in Ayrshire, and since then has extended to many other Scotch rivers, among the first of which were the Tweed and North Esk.

The disease did such immense injury that a Commission was appointed in 1880 to investigate it, and a report, which was published in the Annual Circular of the Fishery Inspectors for England and Wales for 1881, contains a very full description of the fungus, and the manner in which it grows on fishes and causes their death, with a most interesting account of its known life history, and many of the influences that can favour its propagation, besides evidence from the localities where the disease was prevalent in its virulent form.

Other reports of the inspectors published since 1881 contain additional information, and much new evidence has been carefully collected by persons living near the affected rivers, whose practical observations have been recorded on all

points that were considered specially necessary to study. Taken as a whole, this evidence is of the most contradictory kind, and shows that fish are attacked by the fungus in large and in small rivers, near the sea and far inland, in pure river water quite unpolluted by sewage or manufacturing bye-products, as well as in rivers where for long distances from the sea every kind of impurity and pollution is common ; and this point in the contrariety of the water question receives full confirmation from the fact of other similar rivers escaping, and no instance of an outbreak occurring in them. Then, again, although the disease seems to prefer salmon, almost every other kind of fish appear liable to be attacked by it ; and the various kind of trout, more especially the migratory ones, are sometimes found dying in numbers, alone or side by side with the salmon ; and as for the salmon themselves, none of them appear to enjoy a perfect immunity ;—large and small, fresh run or old fish, all suffer, though in varying numbers, and with marked differences in separate localities. It is observable that, as a rule, it is the large spawning fish that are attacked ;—no instance of epidemics among the freshly-run clean salmon is, I think, noticed in the reports of the inspectors ; but even this occurs in Ireland. The only other point on which any kind of consistency occurs elsewhere is also contradicted here, as, whereas in other localities the disease almost always occurs in winter, or at least during cold weather, it breaks out in Ireland not only in summer, but also in the clean, freshly-run fish.

Winter epidemics of salmon disease are far more disastrous in the injury they cause to a river than outbreaks of the disease on freshly-run fish during the summer. In the former case the fish are not only congregated in far greater numbers, but they are usually killed during their spawning operations ; on the other hand, during an outbreak that requires the stimulus of heat, and attacks fish that are accidentally wounded, owing to their difficulty of freely moving in very low water containing numerous obstacles, the injury is confined to the varying number of fish that are actually killed, as it does

no injury during the spawning periods. Such a summer outbreak can hardly be considered an epidemic, though with a continuance of these unfavourable conditions for the fish, it may eventually develop into one.

Since attention has been drawn to the subject, it has been shown that isolated instances of the same disease causing death (generally during the winter months) are not uncommon, and are still frequent even in rivers where the epidemic form is unknown; and it is likely that such isolated cases of death among salmon from fungus have always occurred, and in all probability always will occur.

It is of interest to know that the salmon disease is not confined to Great Britain. In a letter that appeared in the *Field* many years ago, a description was given of it as occurring in the most virulent form in Siberia. The observer, Commander Stuart, of the Navy, reports that in a river running into Castries Bay he saw thousands of dying salmon in all the stages of disease. He adds that they presented the usual appearance, and were covered with fungus. Such was their condition, that when he was wading in the river they did not even attempt to swim away, so that he could have killed them with a stick. I also am informed of a lake in Russia where the disease appeared and nearly killed all the fish. In this instance the fish were of the coarse kind—perch, pike, soam, and I suppose carp, which are very common there.

The appearance of the disease on a fish is first marked by a greyish spot, generally of a round shape, and if it be situated on the dark skin of the head or back it is easily observable. I have often watched the fungus growing from a favourable position, and it is astonishing how rapidly it will spread, by fresh growth at the edges. The fine threads or stems of the growing fungus form a kind of halo round and enclosing the spots by their standing out into the water. On a fully developed patch of the disease, these filaments will protrude for more than an inch into the water, growing as thickly as they can stand. The fish, when diseased, often rush madly about, and

rub themselves against stones to try and detach the fungus, but such efforts, of course, only cause wounds and injury to the epidermis, while opening fresh ground for the disease to penetrate, though in the case of open wounds there are probably other organisms besides the fungus that can hasten the end.

The fish are liable to be attacked all over the body, but the back or the head, and the region of adipose fin (where they are not protected by scales), are the worst places. I have seen fishes quite blind, and with their bodies almost covered with the growth ; but it is the usual practice to snare the fish, and remove them from the water as soon as they are seen to be badly diseased.

The time that elapses before a fish can be actually killed by the fungus varies according to the season of the year, and the rapidity with which the fungus grows. In winter it is not unusual for a fish to live for ten days or a fortnight with the disease growing all the time, but in summer death will follow in half that time.

Some idea of the injury that can be caused to rivers may be gained from the published statistics of the Fishery Inspectors, where we learn that from the River Esk as many as 350 dead salmon were removed in three days ; while in several other rivers the disease has been known to kill in a month or two as many salmon as would equal half the take of an ordinary fair season.

The disease, though not doing as much injury now as formerly, is still prevalent in many of the same rivers, and others are being added to their list every year. It often disappears for a year or two, only to break out again nearly as badly as ever in the same locality, and the reason why the fish should suffer so terribly *now*, when the disease in its present epidemic form was unknown a few years ago, has not, I think, been satisfactorily accounted for. As long as this is the case, its disappearance cannot with certainty be assured ; neither can we feel confident that it will not break out again.

The origin of the salmon disease is (as is the case with all

similar life) a seed, or, as it is usually called, a spore. These seeds, when existing in a water, are always seeking fitting soil to grow upon, and when they find such a nidus they germinate and take root. If the place where they start into life is favourable to them, and the nourishment they find there of a suitable kind, and in plenty, they develop freely, and continue growing until the supply of food is exhausted, or until some unfavourable condition arises to prevent their further development; but it would be rare in an open water, and more especially in a river, for an unfavourable influence to overtake them unless artificially produced; and so, while growing, they rapidly produce and mature their own seed, which, when the plant flourishes, is being continually liberated into the surrounding water, and there distributed, to be again planted on the nearest soil obtainable, where the re-production continually goes on. Thus a water may become charged with the spores of the disease, each and every one of which is ready to develop on the shortest notice and carry on its destructive function, when such a food as the epidermis of living salmon presents a favourable ground for it.

Salmon disease, as you are no doubt aware, is a fungus, or low form of plant life, of the genus known as Saprolegnia; the particular kind with which we have to do belongs to the Saprolegnia ferax group, of which again there are three recognised forms, named Torulosa, Monoica, and Thureti.

The life history of several families of the Saprolegnieæ was very carefully worked out by Cornu nearly twenty years ago, and many of the most famous of the later German, French, and English biologists have paid much attention to the subject, and from time to time published their researches; the latest original papers on the Saprolegnieæ coming from the pen of Professor Hartog, of Queen's College, Cork.

It is known that salmon disease is generally propagated from zoospores, which are the ordinary everyday seed of the plant. These spores, like grain, are matured at the extremity of their stems, or hyphæ, in an enlargement called a sporangium, and

when the seeds are ripe they are expelled or liberated from the sporange into the surrounding water, where their distribution becomes at once general. These spores seem to possess the power of moving at the instant of their liberation, but their energy is almost expended when they are free, and their voluntary motion only carries them a very short distance, when they settle down and become quiescent, unless carried away by currents. This spore, at an undetermined, or, more properly, *varying* time after liberation, has again the power of voluntary motion, imparted by flagella, as in the first case. The first form of zoospore is ovoid with its pair of flagella from the front or narrow end ; the second form is uniform with an anterior and posterior flagellum diverging from the hillum. The existence of these two forms constitutes the phenomenon of diplanetism. The zoospores seem able to germinate at very short notice, growing immediately after liberation if suitable food be near, but their vitality does not seem to have been very carefully studied.

The continuance of the reproduction of the Saprolegnieæ is provided for, under prolonged unfavourable conditions, by another kind of spore that is far more resisting, being able to retain its unimpaired vitality and readiness to germinate even after a lapse of several months. These latter seeds or spores are called oospores, and they are developed, matured, and rendered suitable to carry on their function in an oosporangium, which is only supposed to be produced under exceptional conditions, of an unfavourable nature to the ordinary life of the plant. In laboratory practice of cultivation they are hardly ever visible, except in cold weather, and after studied departure from the usual methods of culture. It is said that oospores not only retain their vitality for a long time, but that a certain period of torpidity is necessary to them before germination.

It is easy to understand that such a provision as oospore formation is quite necessary, and that without it the fungus of salmon disease might become extinct, except in such climates as would favour by temperature a continuous development

from the zoospores, with their rapid growth and ready germination in quickly succeeding generations. Such favourable conditions to their life are not attendant in our climate.*

With favourable conditions, the ordinary life history of the fungus of salmon disease is very constant. The spore, after taking root and sending out its branches in search of food, sends off the ordinary stems or hyphæ from them. These appear at first as a quantity of protruding stems, rounded at the ends, and in very close proximity to one another. They grow out into the liquid straight from the roots, and their filaments appear at times like a bunch of carrots, but instead of being pointed they are of a fairly regular diameter for their full length. The length to which these filaments grow varies greatly; they may on a fish be an inch or more in length, but in cultivation often do not become longer than $\frac{1}{8}$ in. When young and developing, these stems are beautifully clear, and appear like long tubes, with no marking or division, but as development proceeds they become darker, owing to the accumulation of protoplasm. In time they gradually swell at the ends, and become round or pear-shaped, or sometimes club-shaped, after which they darken more and more, and at the base of the enlargement a division appears, which prevents the further circulation of the protoplasm. This club-shaped enlargement is called a sporangium, and the zoospores are matured within it by a gradual process which is very interesting to watch. The dark mass of protoplasm in the sporange soon appears to be divided into a number of small sections which, gradually becoming lighter or more transparent at their edges, are seen soon afterwards to be round, and present the appearance of a mass of well-developed seeds, lying closely packed together like shot in a cartridge. This process of maturing may last twenty minutes or half an hour, and when complete the apex or end of the club is generally seen to have a pointed or beak-like shape. When

* Since writing the above I have had such a favourable series of oospore cultivations as to cause me to considerably change those views. (*See* Note, p. 62.)

the spores are fully matured they press on the pointed end of the sporange until it opens, when they hurriedly escape, one at a time, into the liquid, and quickly settle down if there is no current to carry them away. These zoospores, as previously described, possess two hair-like tails, which by rapid movement give them motion, but although they are usually credited with lively movement immediately after liberation, this is not always the case with the species I have had under observation. After emission they become protected with a thicker coating or cell-wall, and at a varying time afterwards are known to become endowed with a second period of movement, which may last for as long as twenty-four hours, the object of this evidently being to assist them in searching for a suitable nidus to grow upon.

After the zoospores are liberated the empty sporangium gradually disappears, and its place is again filled by another sporangium, which has been forming on the same stem during the time the previous crop of zoospores were maturing. It presses forward into the place of the old one, or inside it, and there the process of spore formation again goes on, and continues at intervals of half an hour or so until the protoplasm collected in the hypha is exhausted. The number of spores that may thus be liberated by such a continuous process can easily be seen to be enormous.

The oosporangium and its contained oospores, as before mentioned, are generally formed at unfavourable periods, when the ordinary spores above described cannot be produced. A bulging appearance then starts at any part of a healthy stem, and pressing outwards as a ball-like protuberance, again thins down to a slight stem at the point where it joins the original stalk. In this round, ball-like cell several spores are formed called oospores. These spores are not liberated, as in the case with the zoospores, but may remain there protected for an indefinite time, or may be liberated by the cell wall opening to allow them to escape ; the continuation of unfavourable influences would probably cause them to remain together until a chance for their germination occurred. It is pointedly mentioned by Professor

Huxley in his Fishery Reports, that oospores are of very rare occurrence, and that other observers, during periods of observation extending over several years, had only seen them on two or three occasions. I am inclined to believe that these oospores may, as "resting spores," be considered to resemble the ascospores of yeast, which are also difficult to obtain, as from ordinary yeast it requires a period of ten days, and starvation conditions, to develop them. When working on ferments in the Biological Laboratory of the Queen's College at Cork, four years ago, I succeeded in obtaining a beautiful ascospore formation in forty-eight hours, and was of course astonished at the rapid production, but the yeast that gave this result was an accidental infection from the plant houses, and I assumed that it was possibly grown from an ascospore, and that for this reason the formation was more rapid than if developed from the ordinary yeast cell, which may have been under previous favourable cultivation (with no ascospore interval) for thousands of generations. I mention this, as I think it is also possible that our salmon disease, under ordinary and favourable conditions of zoospore culture, may become less and less adapted to readily assume the oospore formation ; and it is the more likely, as observation has probably been confined to laboratory cultivation under favourable conditions, or taken from salmon dying during epidemics, whereas, had the salmon been these of isolated cases in healthy rivers, the result may have been different.*

* I have been able to obtain striking confirmation of this opinion during the months of May and June of the present year. Starting with a Saprolegnia ferax growth that had been in favourable laboratory cultivation since December, I after much trouble (lasting over three months) got a gradual oospore formation, which received every encouragement, until on the 1st May the oospores were plenty, and fully developed. Fresh flies were then inoculated from it, and on the 3rd of May a visible young growth had occurred on them, which continued to grow favourably, and showed full filaments and zoospore formation by the 4th of May. On the 5th of May I observed the first tendency to form oosporanges, and on the 6th I was able to define and make drawings of several true examples of fully-matured oospores—that is, in 5 days and 8 hours after adding the fresh fly; temperature varying between 49° and 58° Fahr.

These oospores, then, are what are termed the "resting stage," or "resting spores," of the plant. All fungoid life, including bacteria, requires such a resting spore to carry it over any prolonged unfavourable conditions likely to overtake it, much in the same manner as grain matured in an ear of corn, which can be made to grow years after it is harvested; though in the case of our aquatic fungus the period of torpidity need not be longer than from winter to summer; and, indeed (as it appears well able to grow all the year round), this provision seems to be meant to provide against long periods of starvation, or other unfavourable influence, rather than against winter weather.

The vitality and distribution of these spores of both kinds seems open to observation and study. In the wet condition as liberated in the water, it is probable that during epidemics, or

On the 8th of May I obtained full confirmation of this result in an independent culture, made also on the 1st May—that is, developed in 7 full days.

On the 9th May, I set up a series of 12 drop cultures for continuous observation, but an invasion of achlya unfortunately got the upper hand of the better part of them; however, I was able to obtain positive results in two of the cultures, and in *four* days had well-defined oospores, though not in very numerous examples.

Again, on the morning of the 8th of June I cut some small pieces of healthy skin from a salmon, and immersing them with some small diseased portions of the same fish, in a large glass cylinder, with an arrangement to maintain a constant stream of running water at frequent intervals, for several consecutive hours at a time, during the first two days. I was able to get a good growth on the small portions of healthy skin, and these were then removed for cultivation to fresh glasses, and I obtained on them visible oospore formation in 3½ days—that is, on the evening of the 11th June. The oosporanges here were few, and growing on the filaments that had ordinary sporanges at their extremities, and the characteristic antheridial branches were in every case absent; but this is not unusual, and the oospores were, in my opinion, capable of ready growth in the normal manner.

These observations, I think, show that the generally supposed necessary condition of a low temperature is not at all requisite to oospore development (and I may add that I obtained a single result of the same kind during the very warm weather of 1887, the development then, however, being accompanied by antheridial branches). They also show that oospores can be produced with comparative ease in four or five days, and that they can grow directly from a diseased fish. Against this, the ordinary growth of the fungus when in favourable laboratory culture is not likely to produce them, and, having such a culture, it is difficult to cause ready oospore formation, even with studied variety in the supplied conditions of growth.

even when isolated cases of the disease occur, they may be pretty evenly distributed in currents ; also, that they settle on the banks or on weeds, and in quiet places, from which, however, they are always liable to be displaced by floods and carried out to sea, or buried in muddy deposits. It is however, probable that there is in all open rivers a continuous reproduction going on, as the fungus will grow on almost any animal matter (and I am assured that it will grow freely on vegetable matter also, but I have had no actual experience on this point) ; and, considering the immense number of spores liberated, even from the growth on a small fly, it is difficult to imagine their absence from any open water. In the dry condition the distribution is, I fear, also very probable. The point does not appear to have been studied, yet it is the most likely way of accounting for a general distribution of the fungus, and may, perhaps, have caused the disease to spread to neighbouring rivers, where, possibly, it had become extinct from starvation or other causes. Let me here describe an experiment of my own that touches this question.

At Christmas time last year I intended leaving home for some little while, and believing my cultures of the fungus might be destroyed during my absence, I thought of collecting some zoospores on paper, by filtration. Accordingly, I poured off the water from a cultivation of the fungus on a fly, through filter paper, feeling assured that the water was charged with zoospores, which would be retained by the paper, while the water, of course, readily passed through it. Afterwards the filter-paper was tied up and hung on the wall of a dry room. My cultivations were then all thrown away, and for a full month I had no time to test the vitality of my dried zoospores ; when I did so the result was rather surprising, as full development occurred on a suitable object in the usual time, and is continuing to-day from the same source.*

* I have not been able to confirm these observations on the resisting vitality of the zoospores of Sap. ferax to the conditions of dryness, although I tried to do so. The conditions of culture at the time of these second experiments were, however, unfavourable, and I do not wish to withdraw anything from the details of an ob-

During epidemics of salmon disease in a river with prevalent high water, immense numbers of spores are in all probability deposited on the banks, and have better chances of remaining there undisturbed than in other situations. When the waters recede, and are followed by summer weather or other drying influences, it would only be natural for dry spore distribution to go on with every favourable wind, and I have no doubt this happens. (*See* Note on pp. 64, 65.)

The conditions for the favourable growth of salmon fungus are not many, nor is the fungus as difficile as some kindred organisms. The first essential condition is the quality of the water in which the growth is to take place, and its full aeration ; next, a proper solid nidus, containing the necessary suitable nourishment that can be quickly assimilated ; and the third requisite condition is a suitable temperature.

The purity or impurity of the water is an important factor, but I am not able to agree with the usual view that impure or polluted water is distinctly favourable to the disease ; in fact, my experience is exactly the reverse, and I know of no reliable evidence that can be justly considered to favour such a supposition. As I shall have more to say on this subject later, I have only to add briefly here, that pure spring water taken at its source invariably gives results of growth that, for favourable and plenteous development, are enough to satisfy anybody.

The proper aeration of the water is absolutely necessary.

servation which at the time gave such positive results. I am aware that contamination may have been conveyed by the water used, or the flies that were employed to cultivate upon, and in confirmation of such a possibility, I may mention that I have twice had an invasion of Achlya in my cultures of salmon disease, and which must in one case have come from the flies used, as the water was previously sterilised by boiling, but this would tend to confirm the experience rather than otherwise.

Of course, it must be understood that, in order to obtain such a result as the one detailed, the zoospores would need to be in their second stage of full maturity before drying.

In the *wet* condition, I have lately had very vigorous and ready development from the zoospores of an intentionally neglected cultivation of salmon disease fungus, after a period of more than thirty days.

Few organisms are so sensitive in their demands for oxygen, and its influence can be watched all through its life history; indeed, a deprivation of oxygen will arrest development at any stage of growth.

Regarding the next condition, that of nourishment, our salmon disease fungus requires a solid nidus, or ground (so to speak), where the spore or seed can readily germinate by sending down branches that penetrate until they find a suitable supply of food. This food is conveyed to the stems, and growth goes on until the outgrowing hyphæ have attained their full length; the circulation of protoplasm then becomes visible, and is soon followed by spore formation and liberation. The growth of the fungus is indeed very like that of grain; it has roots and stems, and forms its seeds in a manner that, even in appearance, justifies the comparison. It is probable that it draws its nourishment mainly from the ground or nidus in which it is rooted; and if the stems be torn from their roots, or the roots be taken from the soil (so to speak) on which they are growing, the plant dies.

The next condition, that of temperature, only influences the rapidity of development. The range of temperature at which the fungus can grow best is probably between 35° and 70° or 80° Fahr. Cold retards and heat hastens its growth. Thus, at 65° Fahr., a generation of zoospores can be developed in twenty-four hours, whereas at 35° or 40° Fahr. it would take several days to produce the same result.

The cultivation of the salmon disease fungus is a very simple matter indeed. There is no difficulty in keeping it growing in a room for an indefinite time, when a start is once made; and as it is easily visible to the naked eye, it is not even necessary to examine with the microscope daily to ensure its proper keeping, as it can be seen at a glance. Five minutes a day spent in changing the water, or transferring to different vessels, is enough in most cases to keep the growth secured.

For starting cultivation it is necessary to obtain a small piece of the disease from a fish, and having put it in a glass with clean

cold water, a dead fly is put in the glass along with the fungus, and the water is then changed once in every twelve hours until a growth of the fungus is observed on the fly ; the original piece of fungus from the fish may then be thrown away. It may take two or three days in cold weather, or one day in summer, to produce a visible growth on the fly, but when once it is started the development of the fungus on the fly is very rapid, and goes on until the seeds of the growth are distributed through the water ; and as these seeds or spores are ready to germinate again, if another fly be put in the water, it soon becomes infected like the first, and the cultivation is thus carried on from generation to generation with absolute regularity.

All fungoid life is liable to be suppressed in the struggle for existence by other kindred organisms, or such other life as can go on and develop side by side with it. It is, therefore, the kind of life that is best suited to the conditions supplied to it that succeeds in the struggle, and for this reason our fungus, as cultivated in common drinking tumblers, requires watching. If the water is not changed frequently, the conditions, at first favourable, will become altered owing to the development of other life, such as infusoria and bacteria, both of which continually grow and multiply side by side with the salmon fungus culture, and if they were allowed to remain they would use up the oxygen and feeding stuff in the water, and actually consume the fungus itself, while also causing ill-smelling products to collect that are likewise quite unfavourable to the fungus. By pouring off the water, the unfavourable organisms, which are generally free and moving in the liquid, are carried away with it, and by repeated washing they are reduced to such a minority that the fungus, which is attached to the fly and living on it, easily keeps the upper hand, and with a fresh supply of well-aerated water it continues to develop freely.

There is absolutely nothing disagreeable in these cultivations of the salmon disease fungus, which can be carried on in any number of glasses in a small room. If any bad smell arises it is always due to the development of bacteria or infusoria,

owing to neglect in changing the water as advised. Such a state of things is, however, never met with unless when using large pieces of nutrient substances, and any thing of the kind is in the highest degree unfavourable to saprolegnia cultivation.

The appearance of a fly or grub with the fungus developing on it is very beautiful; the fine growth of thread-like stems standing out into the liquid in every direction seem to envelop the object it is feeding on in a kind of halo, but when closely observed the appearance of a tuft at the extremity of each stem or hypha can be seen with the naked eye in a good light, though the numberless growth of stems as they radiate from the object confuses the sight, and renders them impossible to distinguish, except at their ends.

This method of cultivation is the usual one followed in watching the life history of our fungus :—it is only necessary to remove the fly from the tumbler on to a glass slip, and, adding a little water, to examine it with a low power; the magnification of 100 diameters being in ordinary cases sufficient, though higher powers can be used without the necessity of using a cover glass over the objects.

For experimental work on the life of the fungus under varying conditions of nutriment, temperature, or any special influence to be studied, cultures in tumblers are not so favourable as the hanging drop cultivations, and to carry on these the manipulation must be somewhat more careful.

Flies have long been favourite objects to cultivate upon, and by their use alone it would be easy to keep the fungus growing favourably for years, with no deterioration or change. In this way I have myself lately kept cultivations under observation for five months, and they are just the same to-day as when I started them from a diseased trout that was sent me by post from Dumfries. It is far more difficult to cultivate in open tumblers from pieces of fish or meat. Professor De Bary, of Strasburg, observed long since that such objects were more suitable for bacteria and other enemies of the Saprolegnieæ, and in order to succeed in cultivating our salmon fungus on them, it

was necessary to work in a different way and with far greater precaution.

The conditions of laboratory cultivation, when carried on in the manner I have described, offer, when compared with the disease as it occurs in a river, one obvious difference. I refer to the important circumstance of river water always being in motion, fresh and well aerated ; while in artificial culture the unfavourable conditions of stagnation are always more or less present. This difference is, of course, all in favour of the river as a situation for the fungus to develop in more favourably, and by reason of other competing organisms, which are generally free in the liquid, being carried away by the currents, while the fungus, attached to the fish by its roots, remains in undisputed possession.

For this reason, it is evident that the salmon disease ought to be studied on the fish themselves as well as by laboratory cultivation. The observer ought to have, besides the fullest local information, every opportunity of examining and studying the varying conditions that surround the fish at the time of their immunity from the disease, as well as during epidemics. By such experience he would probably be able to collect evidence having direct bearing on the disease, instead of puzzling and contradictory reports, which are all that we at present possess.

The fungus of salmon disease is the same all over the kingdom. Most observers agree that in every river the type is identical. My own observation on this point is not confined to the disease as it occurs in Ireland. I have had the Scotch and English fungus under observation for long periods, and cannot observe any morphological or other difference at any stage of development. The variety is probably Saprolegnia torulosa. Each kind of the fungus, whether Irish or English, will occasionally assume differently-shaped sporanges under varied conditions of culture.

It is within the bounds of possibility that the salmon disease fungus could be made, by a series of adapting cultivations

under varying conditions of temperature or aeration, considerably to change its accepted life history. It is just possible that this may be a reason that the disease did not appear long ago, or, having appeared, may be a cause of its still continuing its yearly ravages. It is not unusual for kindred organisms gradually to become suited to conditions that, if suddenly supplied, would have been quite unfavourable ; and the fungus of salmon disease may have become far more suited to produce the injury it at present causes than it formerly was, owing to a gradual series of adapting reproduction in generations becoming slowly better able to grow upon and assimilate a food to which they were previously unaccustomed or unsuited.

Our fungus has, I believe, been called Saprolegnia ferax since the salmon disease became prevalent, but it had been known and studied before then. Its present destructive function is, then, only a lately recognised one, and one to which it may have been partly trained by some favourable, but formerly unusual, condition that is now present. It would be as wrong to think that fish destruction is its special mission as that it had lately sprung to life *solely* to bring about the wholesale injury at present so common. It appears to me far more just to think that some unstudied influence has latterly existed to disturb the nice balance of favourable life conditions essential to the fish, when considered with the dangerous function of the parasite, and that such an unfavourable condition can alone cause the fungus to thrive with a special function in rivers where it was formerly harmless, and is so still in the same waters for long periods of each year.

It would be very difficult to prove, and as unsafe to infer, that the fungus of salmon disease does not exist in all open running waters where fish live. Such water is its natural element, and its ordinary function appears to be to purify the water by attacking and reducing any dead animal matter it can find ; but other organisms, better suited under ordinary conditions, are generally more prevalent for this work, especially

where they are favoured by quiet water. Where, however, suitable food is to be found in a river, and our fungus can fix its roots, it would be an extremely difficult, if not impossible, task to exterminate it without the use of an antiseptic, which would be injurious to the fish also ; for its very quick and plenteous reproduction, the diplanetic provision of movement possessed by the spores, and their long periods of torpidity to resist starvation on unfavourable surroundings, render the fungus extremely resisting. When endeavouring to account for these periodic outbreaks of salmon disease, it is necessary to consider the conditions of favourable life in the fish as well as the fungus, and to do this in the broadest sense. The problem is a most difficult one, as the practical evidence seems to be contradictory at almost every point; but there are a few elementary facts that at the outset are forced upon us. The distribution of the spores of the fungus of salmon disease is so general that it would be unsafe to assume that the outbreak was due to their sudden arrival and introduction into our rivers. On the contrary, we have every reason to believe that the disease in isolated cases has never been absent from our rivers—indeed, such instances are now of frequent occurrence in rivers where the epidemic form of the same disease is unknown. The periodic manner in which the disease breaks out, and again disappears to occur surely the following year, clearly proves that fish can live happily in infected rivers—that is, in waters where the spores of the fungus pre-exist, and possess the same readiness to germinate as before. If this was not the case, epidemics would be more frequent, and theoretically, at least, not a fish could escape. The manner in which fish can live side by side with the fungus is also illustrated by the way in which trout can thrive in water that must be swarming with the seeds of the disease as liberated from diseased salmon at the time of epidemics, and yet not be quite invulnerable, as occasional trout have been known to die of salmon disease during these periods. During the warm weather of last summer I was present when a net was drawn, and nearly a hundred salmon taken from a river ;—the net was used, as

many diseased fish had been seen in the locality, and it was quite impossible to take them by angling. When the fish were landed it was found that only a small proportion of them were actually diseased. Many of the fish were very fine ones, and they were of all sorts—large salmon and grisle—some fresh from the sea, others brown, thin, and generally attenuated, as such fish become by a long sojourn in fresh water. Some of the best and freshest run fish were the worst attacked, while several long, brown fish were quite clean ; and yet these fish had probably been all together for some days at least. After their violent struggles in the net the salmon were all well cleaned of the fungoid outergrowth, and a tremendous crop of spores must have been sent down the river. I was allowed to take some pieces of diseased skin with me for intended cultivation, but, strange as it may appear, could obtain no fungoid development from them—they had been so thoroughly cleaned by the fishes' struggles ; and yet I heard of no trout becoming diseased, and they were there in plenty, as, by kind permission, I myself fished the river shortly afterwards, and had good sport with fairly large fish. Mr. Murray, who conducted some very interesting experiments for Professor Huxley, says that to inoculate healthy fish they must be stroked or rubbed on the epidermis with the fungus, so that the spores will stick ; and I myself have had fish living healthy in water to which the spores of the disease were intentionally added.

There is an interesting experiment contained in Mr. Sterling's paper on Salmon Disease. Having obtained some live minnows, he added to the water in which they were living some pieces of salmon skin with the fungoid growth in full development upon them, and watched the result. The minnows, instead of waiting for the fungus to attack them, actually started to eat it, and nibbled away at it as long as they were allowed. They seemed to enjoy it, and there were no disastrous after-effects ; the fish continued healthy. If it be accepted that the fungus can assimilate dead animal matter without of necessity attacking live, healthy fish, some explanation of its periodic

ravages may be found easier ; and this is not unnatural to believe, as the disease in all rivers seems to appear suddenly, and to cause the death of a varying number of fish, after which it will die out, and then for months not a case of disease is heard of. Now, the spores of the disease, as before explained, must remain in the river during the time that the disease is not prevalent, and the pertinent question is then forced on us, "Why are the fish not liable to the disease all the year round ?" The partial explanation of this, I venture to think, is that the temperature of the water is one cause, together with coincident conditions that are of almost equal weight. In giving this as my opinion, let it be understood that my experience refers to a river where the outbreak of the disease is very different from the epidemics in England or elsewhere that I have read descriptions of, as it occurs in summer instead of winter, and attacks clean run fish instead of spawning salmon or kelts ; though the important point of a few fish dying in winter also in the same river ought not to be forgotten.

That our salmon disease fungus will develop far more rapidly in summer than in winter is, I think, beyond doubt. Laboratory cultivation of the fungus never fails to show this clearly ; but if a proof be necessary, let a piece of diseased skin be taken off a salmon from a river where the water is under 50° Fahr. ; put it in a glass vessel with clean water, and transfer it to a warm room, where the temperature is about 60° or 65° Fahr. Under these conditions I have seen the stimulus of heat cause a second growth under the first, and the line of development in such growth clearly defined to the naked eye. It has been said that temperature seems to exercise no influence, as the disease can go on causing destruction during the coldest weather ; and this, when referring to winter attacks, is quite correct, as far as it goes, in proving that the fungus can develop even in the cold quickly enough to kill fish ; but in these cases the many other coincident conditions on the side of the fish must be extremely unfavourable, and would only suggest that with warmer water, and other conditions remaining the same, the

salmon would be killed in half the time, and probably in far greater numbers.

But the stimulus of heat is not sufficient to account for an outbreak of the disease, and it must be coupled with the fact that in summer the water is low as well as warm—so low, indeed, that in some cases the fish do not find an open passage when trying to enter from the sea, but have to struggle over shoal water, and are often even unable to enter for want of water until a flood gives them a chance; but if there should be water enough to enable them to struggle over a long bank, it is only fair to assume that in a river, where they are to some extent strangers, they are very liable to injure themselves on stones in their efforts to ascend, or on weirs or such natural obstructions as are to be found in some rivers when the water is very low, and no open passages exist.

By injuring themselves, I do not mean necessarily that fish must become actually wounded, but that they may thus injure the delicate epidermis or slimy coating that covers their skin, and which in a perfect fish not only answers as a complete and impervious coating of protection, but by its continually exfoliating on the surface, could also displace any accidental fungus spores that were planted on it, before they could germinate. The rate at which the exfoliation process goes on over the skin of a salmon in good health is probably pretty regular. We have no definite reason to believe, in the event of a scratch or injury to the epidermis, that in that particular spot the rate of growth would at once be increased; and the question is one of obvious importance, if we consider that, while the rate of growth with the fungus is immensely increased during summer, the protecting epidermis of the salmon, at a time when it is more liable to injury, during the time the water is low and warm, grows at the same rate. All growths of salmon fungus can easily start on a broken epidermis. It seems to be the most favourable nidus for them to take, and one on which they to all appearance develop most readily.

I may here mention that in cultivation practice it is usual to

employ meal worms, as they are easily obtained, but it is often difficult to cause the fungus growth to start on them. If, however, after killing them they be punctured with a needle, a ready growth starts from every point where the needle entered.

I regret that I have not had opportunity of examining many diseased fish, but on the few I have seen the epidermis was much injured—in some cases, indeed, the true derma underneath also; and I am informed that the disease only attacks fresh fish in summer on the spots of such injury, but am not anxious to lay weight on second-hand evidence, however honestly given, as a scratch would not be easy to discern with the developed fungus upon it, and diseased fish are liable, by rubbing themselves against stones, to cause such injury at these particular places.

Last March I was witness to the killing of a fine spring fish of 17 lbs. weight. At the time the river was quite low, and its temperature about 46° Fahr., and no instance of salmon disease had been observed in the river for fully six months. While examining the fish as it lay on the grass I noticed a slight scratch on its head. Although the scratch was in itself insignificant, I thought I could discern a fungoid development in it, and called attention to it, but the angler and his gillie were quite unwilling to allow that it could be fungus. Such scratches, I was told, were quite common when the river was low, and always healed quickly, and the gillie protested that a fish would not rise to a fly if the smallest speck of disease existed on it. Not being satisfied myself, I took out my knife and extracted what, I felt convinced, was a particle of growing fungus; but, to make matters more certain, I removed the remainder (only a speck in all), and placing it in wet cigarette-paper, put it carefully away in my tobacco-box, and on my arrival home I was fully able to confirm my opinion after a microscopical examination; and starting some culture experiments *from it*, I obtained ready growth and a fine crop of true fungus in a short time. The importance of this observation lies in the fact that the disease did not break out in the river with its usual virulence

until nearly the end of May (or two months later), and no single instance of it was observed till then, when the water was about 56° Fahr. The fact of my finding a fish with a healthy young growth of fungus on it showed plainly that the fungus existed in the river, and that a small scratch was enough to ensure its developing, though so slowly that I feel sure I am right in thinking with the gillie that the wound would have healed in a few days; and such scratches could not have been unusual with the water at almost summer level, and fish running regularly at the time.

I knew from previous experience and study of the marked stimulus of heat given to low plant life of many kinds besides salmon disease, that it might be the cause of the disease breaking out in summer, and after my observation I was confident that with heat and low water the disease would again become prevalent. This belief was, unfortunately, confirmed; and, though the outbreak occurred fully a month later than usual (as it was coincident with a very cold spring), it promptly followed the arrival of the first two or three days of really warm weather, and with such exactitude, that I was myself somewhat surprised. (*See* Appendix, p. 82.)

The question of possible stimulus imparted to the fungus by the heat of summer weather does not appear a necessary factor, as in most rivers the epidemic form of the disease occurs during winter, when the water is at its coldest, and the fungus would in such water (other conditions being equal) develop much more slowly than in summer.

But the condition of temperature variation is one to which all organisms of the kind can adapt themselves quickly, though of course only to a limited extent. In winter epidemics the simplest explanation suggests that the fish themselves offer at that time the best opportunity for the fungoid attack. During the periods of spawning the fish are often in a very degraded condition of health—reduced by their long stay in fresh water (where, it is generally accepted, they do not feed) to the most pitiable condition of weakness. They often seem to possess

hardly any vitality, and natural death is at such a time not uncommon. The spawning operation, when the fish are continually routing among the gravel in the running water, would naturally result in opening the epidermis and exposing the skin; and it is also said that fish during spawning time will fight viciously. The condition of health in fishes, I am inclined to think, has much to do with the salmon disease, and one of the first consequences of a low vitality may be a slow or imperfect excretion and epidermic formation. Sickly fish of all kinds are often attacked and die of fungus, when the real exciting cause of death was a low vitality occasioned by sickness or old age; and our fungus often breaks out in aquariums, and kills such fish. Fish that die in rivers are probably the legitimate food of the fungus, and one of its special means of propagation during long winter periods, when rapid development is impossible, and when the species also runs the extra chance of extermination owing to the deposits of mud during floods in the quiet eddies, where the spores would be likewise deposited.

Is not the possibility of the deterioration of a stock of salmon also an open question, when we know that they always return to the same rivers in which they were bred? It is possible for a river greatly to change in a period of years. A good system of surface drainage adopted on the banks of a river and its tributaries, where for years before the water was allowed to collect and gradually flow off, would lessen the volume of a small river to a considerable extent, and account for the running dry of springs; a succession of dry seasons on a water naturally impure might also promote the same unfavourable condition by concentrating these impurities; and with such a state of things existing, would not a stock of fish deteriorate, and become more liable to this fungoid pest? It is certain that salmon vary very much in appearance, and that their strength (as evidenced by angling experience) may vary also in different rivers. Trout vary also in condition, vigour, and size; but while it is in all probability the feeding qualities of the water in which they *entirely* live that cause the trout to

differ, the case is quite different with salmon, as they are said to feed only in the sea, where the chance of supplies ought to be pretty constant ; and salt water fish do not present the varying appearance of salmon, which, from two neighbouring rivers, and probably the very same feeding grounds in the sea (as in the sea nets they are caught together), present such variations in appearance as to render the salmon from each river recognisable at a glance. The conditions in the sea being, then, impartial, as open to the fish of different rivers, it must be the sojourn of the fish in fresh water, where they are bred, that influences their appearance, strength, vigour, and eating qualities; and a predisposition to take the disease may thus descend by inheritance.

The pollution of a water is generally supposed to favour salmon disease, and the opinion is even prevalent that it can originate it. The latter view is, of course, quite impossible, as the origin of the disease is undoubtedly the spore or seed that it grows from, and which can only be produced by the fungus itself. The direct influence of pollution, in the present undefined meaning of the word, is apparently of little real weight, when we consider as a *fact* that the cleanest water is as favourable to the growth of the fungus as can be desired to account for its ravages, and that the ordinary pollution of rivers from towns or manufacturing sources would in all probability be more unfavourable than otherwise to the fungoid growth. It is on record that many of the cleanest rivers in the kingdom have been the scenes of bad outbreaks of the disease. A case occurred in Sheffield a few years ago, when as many as a thousand trout died of fungus in a reservoir that supplied the town with water, the quality of which was certified by the City Analyst to be quite as good as usual. The people of the town were, indeed, drinking it all the time.

We have also the fact that aquarium fungus is and always has been common, even when supplied by the town pipe-water, as aquariums usually are. Against this, consider that some of our polluted rivers in the neighbourhood of the diseased are quite

free from the epidemic, and that among these rivers are some which are so contaminated for long distances from the sea as to cause wonder when we think that salmon can live to ascend in them—instance the Liffey.

If pollution exercised a *directly* favourable influence on our fungus, the ordinary outbreaks of the disease ought to occur during the summer, when such impurity is concentrated ; but, instead, we find that the virulent outbreaks of the disease occur during the winter, when by the prevalence of floods the pollution must be reduced to its maximum dilution. with water often running banks high all the time.

I am convinced that any injury resulting from pollution must be expended on the fish themselves, and only think it possible that conditions perhaps favouring the fungus may be thus indirectly brought about. Impure water cannot be favourable to the fungus any more than to the salmon ; but when it only exists near the mouths of rivers, and the fish have ample opportunity of ascending to good water for their spawning operations, there is probably not much injury done. If so, it is the more to be regretted, as nearly all our salmon rivers are more or less polluted near their outlets to the sea, and some of them to a horrible extent. Overcrowding of fish in holes could not well cause the disease, although this is frequently believed. Such a theory only finds support when absolute contact of the fish one with another is considered necessary, and this is not the case unless with perfect fish, having their epidermis uninjured, and when a diseased fish might infect or inoculate a perfect one with a blow, or rubbing movements, which would plant the spores in its skin. Such an influence as acidity or alkalinity can certainly have bearing on organic life, but rigid research with our fungus does not inform us in any definite way whether the influence would be favourable or not. The probability is that both fish and fungus might die under it, the fungus first, and both be consumed by a race of bacteria better suited to the circumstances. The salmon disease fungus is (if it may be so called) a decidedly clean feeder, and decaying organic matter or sewage pollution would certainly be unfavour-

able to it. The method it has of taking up its nourishment through its roots is essentially different to that of the ordinary organisms of decomposition, which, moving freely in a liquid, assimilate through their pores. A possible stimulus, therefore, given by food in solution, is for this reason doubtful, and even if the fungus could take it up, I hold that it is quite unnecessary.

The disease cannot originate in salt water—there can be no doubt of that—as not only are freshly-run fish always clean, but no reliable instance of the disease occurring in salt water is on record. Experiments of my own, in mixtures of salt water varying from full strength to high dilution, have been quite negative in the strong salt solutions, and though a mixture of one salt water in six of fresh will allow the fungus to grow, its spore formation is faulty, and development not normally healthy. In a salt-water solution of 10°/₀ strength, growth was not unfavourable, and plentiful sporulation resulted.

To apply a remedy to the running waters of a river would be an ungrateful task, if not an impossible one. The spores of the fungus have all the appearance of being able to resist conditions that would kill any fish; but if a fish is removed without injury from a river, the fungus can be killed with a sprinkle of alum or borax, or even common salt, and I am told of the favourable use of a weak permigranate solution, but this requires to be skilfully and quickly done, and the fish must then be put in an enclosure and watched, and the remedy again applied if necessary. Such treatment is, I believe, not uncommon in fish-culture establishments, where the disease is frequently met with, and fish of all kinds are often cured. Remedial measures ought rather be searched for among possible changes that may have crept in during long periods of years to influence the vitality of the fish themselves. The fungus is having the best of the unnatural struggle just now, and will continue to do so as long as it is favoured by such chances. A sickly fish, or one wanting in its power to resist fungoid attack, could not be recognised by its eating qualities, and the conditions of unfavourable influence on salmon, though in themselves unchanged for

years in the rivers, may have resulted in gradual degeneration of the fish in some important point of their strength or vitality. This latter opinion is not a new one, and is obviously the first that would suggest itself to any impartial mind with some knowledge of the subject.

The fungus appears to be exercising its instinctive mission, thriving and living freely, while enjoying unusual opportunities. It seems almost to take possession of a river, and the fish are unable to resist its attacks. There is nothing mysterious, so far as the fungus is concerned, in the manner in which this is brought about. We probably know as much as is necessary about the fungus, and any points in its history that remain unstudied could be worked out with exactitude to the smallest detail with time and patience. Can the same be said for the salmon? I believe not; and I venture to think that it is the missing link in *their* history which requires all the energy of investigation to elucidate this subject. If the disease should eventually die out and leave our rivers improved rather than otherwise, the theory will be forced on us that it is due to the succession of an improved and more vigorous race of fish having succeeded the ones that succumbed to the disease earlier; but we shall have learned that the epidemic may again appear if degeneration to the same extent should give it another opportunity of flourishing; and the lesson will probably cause to be introduced many necessary measures now imperfectly understood, or disregarded as of but trivial importance.

One apparently astonishing fact has been revealed by the Fishery Inspectors' statistics, as we learn that in some of the rivers where the disease has been most virulent the value of fishing (calculated from the number of salmon taken) has greatly *increased*, while in other rivers the class of fish are reported as being much improved. Such facts would suggest that there may be a hidden good even in salmon disease by its killing off weakly fish, or pointing out defects or changes, that may have gradually arisen to interfere with their happy life history.

EXPLANATION OF PLATE OPPOSITE.

I am indebted to Dr. E. A. Letts, PH.D., &c., President of the Society, for a beautiful series of micro-photographs, which he with great kindness prepared for me, and from which the present illustrations are copied.

These micro-photographs were taken from my own mounts of the fungus, that were specially cultivated in small cells on fragments of flies' legs, and fixed for mounting at the different stages of development in the actual position in which they grew.

No. 1. $\frac{1}{40}$. A young, developing growth; the darkened ends of the hyphæ show the accumulations of protoplasm, and the tendency to form sporanges.

No. 2. $\frac{1}{50}$. A more abundant growth at a later stage of development, the formed sporanges being nearly mature.

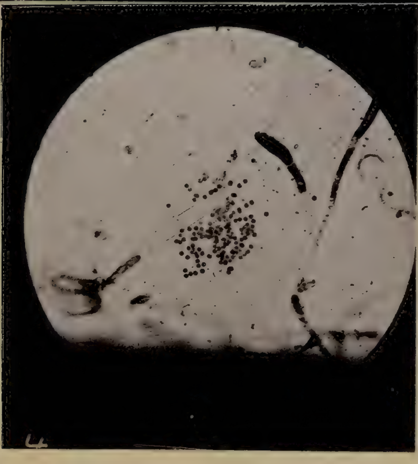
No. 3. $\frac{1}{70}$. Increased magnification at the same stage of development as No. 2. The black markings in some of the filaments are not natural, but caused by the action of an antiseptic fluid in which the growth was mounted.

No. 4. $\frac{1}{140}$. Liberated zoospores, just emitted, and the empty sporange that contained them.

No. 5. $\frac{1}{100}$. Oosporangium and oospores, imperfectly defined.

No. 6. $\frac{1}{80}$. Dark ground illumination. Number of liberated zoospores and differently shaped sporanges.


3



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5


6

APPENDIX TO PAPER ON THE FUNGUS OF SALMON DISEASE.

In further confirmation of my opinion on the influence of temperature, I this year kept a regular daily observation of the temperature of the water from the 30th of March till the 10th May—that is, from a time before the usual period of the outbreak of the disease, and continuing until the salmon were found dying of the disease in the usual way.

I also kept some notes of the results of the angling during the same period, and had opportunities of examining a few of the fish that were caught by the rod, and others that were caught by nets in the river, every opportunity being afforded me of so doing, though I regret that owing to my being very much occupied at other work, I was not able to take full advantage of my chances.

The following are the temperature observations, as taken daily:—

	Deg. Fahr.	
March	30—48.	
,,	31—49.	
April	1—45.	Wind N.
,,	2—45.	,,
,,	3—39.	Frost at night.
,,	4—39.	,,
,,	5—37.	,,
,,	6—43.	Cold and wet.
,,	7—43.	Weather not noted.
,,	8—43.	,,
,,	9—42.	,,
,,	10—41½.	,,
,,	11—41½.	,,
,,	12—44½.	,,
,,	13—44.	
,,	14—45.	
,,	15—46.	
,,	16—46½.	
,,	17—48.	
,,	18—49.	
,,	19—51.	
,,	20—50.	
,,	21—50.	
,,	22—50.	Rain and flood water.

	Deg. Fahr.	
April	23—49.	Rain and flood water.
,,	24—47.	,,
,,	25—48.	Weather fine.
,,	26—50.	First fish diseased caught in the nets.
,,	27—48.	
,,	28—48½.	
,,	29—48.	
,,	30—47½.	Another slightly diseased fish caught in the nets.
May	1—49½.	
,,	2—51.	
,,	3—49.	
,,	4—51.	
,,	5—53.5.	First really warm day.
,,	6—54.	Still warm; much rain.
,,	7—57½.	Warm weather.
,,	8—56.	,,
,,	9—57½.	
,,	10—59.	

During the month of March, and until the 17th April, angling was, I believe, attended with more success than has been usual of late years: two or three fish were usually killed every day, and often more. Of these fish, I saw about a dozen at different periods, and was able to observe on almost every one bruises, or some marks of slight injury. Several fish (I think I saw *three*) were also badly wounded, and it was an accepted opinion among the anglers that porpoises or otters may have bitten them, which, as the wounds were so large, seemed probable, though on this point I am not qualified to give an opinion.

From the 21st to the 23rd April flood water was prevalent, and many fish were killed with the rod. On the 26th April several fish were caught by nets in the river, and I was shown one or two that had suspicious marks, and as though fungus had grown on them, but these wounds were all thoroughly cleaned of all outer growths by the fishes' struggles in the nets. I took several small cuttings of what appeared diseased skin home with me, and, remembering my previous failures to obtain growths from such cuttings, I mounted an arrangement to admit a constant stream of water on the pieces of fish skin that, attached to a hair and submerged, were under observation. After two days I was able to observe a good growth of Sap. ferax on two of the pieces, but it did not appear on all of them (no doubt, partly because my means of obtaining the constant stream of water was difficult, and needed continual watching, for want of proper appliances and pipe water). On taking out the growths, and removing them to a warmer locality in a separate vessel, the development of the fungus was greatly increased, but was quickly overtaken and suppressed by other forms of organic life, which developed so quickly as to render the water quite turbid and ill-smelling in a short time. The Saprolegnieæ then, of course, went to the bad, but not before I had had several microscopical observations of it, and had quite satisfied myself as to its identity.

On the 30th April I had a confirmatory observation of exactly the same kind, from small portions of the deceased skin of another fish caught also by nets in the river, the fungus again developed under running water and gave as before plenteous zoospores.

I venture to think these observations show that the fish from which the cuttings were taken had been attacked by the fungus, but that the growth was not sufficiently quick to cause the fish to die, and I am forced to believe that with the water becoming colder they might have recovered, or that with water constantly at say 45° Fahr., the disease would not have develped on them to a dangerous extent, as the disease in its worst form did not break out until a fortnight later, when the conditions in the river were changed, the water being then quite low, and its heat nearly 60° Fahr.

The 5th May was the first really warm day that we had here this year. By the 7th of May the water registered 57½° Fahr., and the weather continued warm and dry. I had observed last year that the water was at about 56° when the disease broke out, and therefore (allowing about four days for the disease to develop) I thought we should hear of the usual outbreak on about the 11th of the month, and made notes to this effect. On the 12th I heard of the first diseased fish being seen, and on the 14th I was called at my special request to see the first fish that, thoroughly diseased,

allowed itself to be gaffed, and I saw two others that were in almost the same condition on the same evening.

All the diseased fish that I saw this year have been "freshly" run salmon, in appearance well up to a good average at their best season.

We have not had anything like the same number of diseased fish this year, and now (25th July) I hear that there have been no diseased fish seen for a month, while in favourable weather they have lately been killed with the rod, which is also unusual at this time of year.

JOHN BROWN, Esq., read a Paper on

FIGURES PRODUCED BY ELECTRIC ACTION ON PHOTOGRAPHIC DRY PLATES.

A RAPID photographic dry plate is laid, film upwards, on a sheet of tinfoil connected to one terminal of the secondary of an induction coil, whose ordinary discharging points are set about three centimetres apart, to act as a by-pass to the spark, and prevent it striking over the edge of the plate. The end of a wire from the other terminal rests on the centre of the film. A single discharge from the coil is caused by moving its mercury break by hand, and the plate is then placed in the developer. When the terminal wire at the centre of the plate is negative, the resulting figure is like that represented at *A*, which shows the typical negative form. When the same terminal is made positive, and a discharge caused under otherwise precisely similar conditions, the figure is quite different, as represented at *B*, which is the typical positive form. The distinctive character of the two kinds of discharge is remarkable and interesting. If wires from both poles are brought down on the plate, laid as before on foil, and the coil discharged, the typical figure is produced under each wire. If the foil be omitted, or if actual spark discharge occur between the terminals, or if the terminals be placed on the back of the plate, other figures of a different character in each case are produced. An account of these appears in the *Philosophical Magazine* for December, 1888, p. 502. Mr. J. Joly, of Trinity College, Dublin, has been struck by the resemblance between these figures and the Oldhamia markings on the pre-silurian rocks.

In making experiments on the hypothesis that these might have an electric origin, Mr. Joly has produced some remarkable figures (differing from those described above) by using, instead of the photographic dry plates, plain glass plates covered with lycopodium and other dry powders. A connection with the Oldhamia markings has not, however, been established.

Photographic reproductions of these figures are to be found in the following plates.

A.

B.

Mintern Bros. lith.

2nd April, 1889.

W. H. Patterson, Esq., M.R.I.A., in the Chair.

Professor Meissner, Ph.D., gave a Lecture on

CHRISTIAN ANTIQUITIES AND WORKS OF ART OF THE LOWER RHINE.

Professor Meissner said that people going for a holiday in the summer season go to the Lower Rhine, see the beauties of the Middle Rhine, and, having done that, proceed to Switzerland. The Lower Rhine is considered an uninteresting country, but he hoped before he had finished his discourse to show that there is a great deal of interest attaching to it, not only historical, but also artistic. The Rhine has at all times been the high road of Europe, and in the Middle Ages was called "The Priests' Road." On its banks were the seats of the three great spiritual magnates of the Roman Empire —the Archbishops of Mainz, of Cologne, and of Trier. The Archbishop of Cologne was at the same time Chancellor of the Empire, and the Archbishop of Mainz was Primate of Germany. Cologne was the first centre of mediæval art, and in its University taught Albertus Magnus, St. Thomas Aquinas, and Duns Scotus, who died at Cologne, and was buried in the Church of the Minorites. The earliest principles of Christian art on the Lower Rhine must be traced to the Irish missionaries, and some traces of it are to be found in many copies of the Gospels. The greatest art of the Christian Middle Ages was the art of architecture on the Lower Rhine, which was Romanesque, while in the rest of Europe the Gothic had been adopted. Therefore there are very few Gothic churches on

the Lower Rhine, but one of them, the Cathedral of Cologne, surpasses all other Gothic churches in beauty and size. The majority of the churches at Cologne were built in the time of Henry the Fowler, Otto the Great, and Adalbert, the son of Henry the First, who was for some time Bishop of Cologne. Gothic art in Germany was especially cultivated in the lowlands of the North and East. The main difference in the appearance of the mediæval church and the modern church was in the colour. Some of those churches have been restored. At the time of the Reformation all these polychrome churches were whitewashed, and at the beginning of the century no archæologist had the faintest idea of the appearance of a mediæval church. The lecturer then went on to describe the church furniture used in mediæval times, especially woodcarving, representations of which were exhibited. He then went on speak of the goldsmiths' and enamellers' art, and pointed out that the best illustrations of the former are to be found in the Rhenish churches. The Shrine of Anno has been greatly despoiled during various invasions, and for some time it was hidden in a barn, and, although nearly all the ornamentation is gone, sufficient remains to show its great beauty. The most famous shrines for workmanship and costliness are those of the Three Kings, or the Magi, at Cologne, and that of Charlemagne at Aix-la-Chapelle. The lecturer here exhibited some representations of processional crosses of the Convent of Essen, after which he gave some interesting information regarding embroidery and painting, and concluded by stating that throughout the Middle Ages art was anonymous. We do not know the names of the architects or painters, but only know the names of the founders and donors, and in that respect mediæval art differs from classical and modern art.

GYROSTATIC EXPERIMENTS.

In connection with the popular lecture series, Sir William Thomson gave a lecture, on Tuesday evening, 16th April, in St. George's Hall, on "Gyrostátic Experiments."

Sir William Thomson said what he wished to bring before them in his lecture that evening bears upon the idea of the explanation by motion of the elasticity and other properties of matter. "Gyrostat" is a Greek word meaning a thing which stands up because it spins round. Probably most of us can turn back our memories to a time in our earlier life when we were diligent students of gyrostatics as comprised in the spinning top, the humming top, and the teetotum. The subject of rotation—gyrostatics—is perhaps one of the most beaten tracks in the plain of dynamics, and a large part of the theory of dynamical science consists in the theory of rotation. All who have studied mathematics, or dynamics mathematically, must know well its fundamental principles. He first called attention to what is called precessional motion, as exemplified in an ordinary spinning top. This is the movement by which the axis of the top becomes inclined to the plane upon which it is spinning, giving the peculiar conical undulatory motion which all have seen who are skilled in the use of the toy in question, or of the teetotum. (The lecturer illustrated the movement by means of tops and teetotums spun upon a glass plane.) He then proceeded to refer to the precession of the equinoxes, caused by the combined gyrostatic action of the sun and moon upon the mass of matter accumulated about the earth's equator, which has the effect of making the equinoxes succeed each other in less time than they would otherwise do; so that it is calculated that the equinoctial points make an entire revolution in about 26,000 years. When the precessional motion is in the same direction as that of the axis it is called positive precession; when it is in the opposite direction it is

is called negative. The difference between the motion of the top and of the earth is that, whereas in the former the conical rotation is in the same direction as the axis, in the case of the earth the pole of the axis turns about the pole of the ecliptic in the opposite direction to that in which the earth revolves about its axis. (By means of a globe and other appliances the lecturer explained the theory of precession and nutation, and their effect upon the polar inclination.) If the earth were truly spherical and homogeneous, or if it were such that the resultant of the attractions exerted on all its parts by any other body should always pass through a definite point in its mass, its diurnal rotation would not be affected by the attractions of any other bodies, and the Pole star would always be the same star. Nutation is a slight oscillatory movement of the earth's axis disturbing the otherwise circular path described by the pole of the earth round that of the ecliptic. In the monthly lunar nutation, the solar semi-annual nutation, and the other movement he had referred to, are comprised the astronomer's gyrostatic problem. There are, however, other problems connected with gyrostatics which are far more difficult to solve. The lecturer next illustrated the rotatory stability of different forms of gyrostats, including prolate, oblate, and ordinary disc and gimbal-formed. He also gave an amusing solution of Columbus's problem how to make an egg stand on end. If the egg is hard-boiled, it is practicable to spin it on end like a top, whereas the viscous fluid in the raw egg prevents its being treated in a similar manner.

He believed, if we are ever to solve the difficult problem of the elasticity of matter, it will be by the aid of the phenomena of rotation. Accepting the undulatory theory of light, we shall see that Faraday's brilliant discovery demonstrates the gyrostatic influence there. Nothing but the influence due to rotation could produce the effect which, as Faraday discovered, is produced by the magnet upon light passing through glass between the poles of the magnet. Some years ago we were all trying to find some kind of association be-

tween the vibrations of sound and the vibrations of light, and a brilliant suggestion made by Professor Fitzgerald (whom he was very pleased to see present) four years ago at Southport gave the key to the solution of the question. He suggested the employment of electric vibrators, and that suggestion had been realised in Herz's splendid work within the past year, and the gap which we so desired to fill had been filled. It is almost impossible to go a step in the study of physics and dynamics without the aid of gyrostatics, and that is the reason the lecturer is interested in them—not merely because the phenomena they present are curious and interesting in themselves. But in studying and reconciling the laws of light, the laws of magnetism, the laws of electricity, and the laws of the elasticity of matter, gyrostatics play an undoubtedly important part.

Sir William concluded with a number of experiments tending to show the effect of gyrostatic domination in giving stability where instability exists, &c. One of the most interesting examples was the propulsion of smoke wreaths or rings, demonstrating the power of rotatory motion on so delicate a medium. Another curious effect obtained was the imparting of stability to water by means of rapid rotatory motion. In conclusion, he said that although the theory of which he had endeavoured to give some explanation is by no means complete, yet it will doubtless in time be rendered so, and meanwhile anything that tends to advance even a step towards the desired end is worthy of our attention.

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Report and Proceedings

OF THE

BELFAST

NATURAL HISTORY & PHILOSOPHICAL SOCIETY

FOR THE

1889-90.
SESSION ~~1890-91~~.

BELFAST:
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3 Shares	,,	,,	cost £21.

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There are two classes—Ordinary Members, who are expected to read papers, and Visiting Members, who, by joining under the latter title, are understood to intimate that they do not wish to read papers. The Session for Lectures extends from November in one year till May in the succeeding one. Members, Ordinary or Visiting, pay £1 1s. per annum, due 1st November in each year.

Each Shareholder and Member has the right of personal attendance at all meetings of the Society, and of admitting a friend thereto; also of access to the Museum and Library for himself and family, with the privilege of granting admission orders for inspecting the collections to any friend not resident in Belfast.

Any further information can be obtained by application to the Secretary. It is requested that all accounts due by the Society be sent to the Treasurer.

The Museum, College Square North, is open daily from 12 till 4 o'clock. Admission for Strangers, 6d. each. The Curator is in constant attendance, and will take charge of any Donation kindly left for the Museum or Library.

Belfast Natural History and Philosophical Society.

ANNUAL REPORT, 1890.

The Annual Meeting of the Shareholders of the Belfast Natural History and Philosophical Society was held on 23rd May, 1890, in the Museum, College Square North. John H. Greenhill, Esq., Mus. Bac., *President*, occupied the chair, and among those present were — Messrs. John Brown, *Hon. Treasurer*; Joseph Wright, William Gray, M.R.I.A.; William Swanston, F.G.S.; J. J. Murphy, Thomas Workman, J.P.; Robert M'Bride, R. Lloyd Praeger, Otto Jaffé, Robert Young, C.E.; and R. M. Young, B.A., *Hon. Secretary*; Dr. J. MacCormac, Dr. Shaw, Rev. L. A. Pooler, and the Rev. Freeman Dudley.

The Hon. Secretary, having read the notice convening the meeting, submitted the Annual Report of the Council, which was as follows :—

" The Council of the Belfast Natural History and Philosophical Society, appointed by the Shareholders at the last Annual Meeting on the 13th June, 1889, desire to submit their report of the working of the Society during the past year. The ordinary Winter Session was opened on November 5th, 1889, when an address was read by your President, Mr. J. H. Greenhill, Mus. Bac., on the subject of 'Work,' illustrated by mechanical appliances and experiments. The second meeting was held on 3rd December, 1889, when three communications were brought forward—Mr. John Vinycomb gave 'Some Remarks on Dean Swift's Autograph and Seal of the Deanery of St. Patrick, Dublin;' Mr. John Brown supplied 'Notes on the Musical

Sand of Eigg;' and Mr. Seaton F. Milligan, M.R.I.A., read papers entitled 'With the Royal Historical and Archæological Society in Limerick,' 'Recent Archæological Explorations, with Special Reference to the Ancient Irish Hot Air Bath,' and 'Notes on a Carved Oak Tudor Panel,' illustrated by special photo slides, &c. The third meeting was held on 4th January, 1890, when two papers were read—on 'The Proposed Vertebrate Fauna of Ulster,' by Messrs. Robert Patterson and R. Lloyd Praeger, B.E., secretaries of the Ulster Fauna Committee, illustrated by rare specimens, and on 'Modern Photography,' by Dr. Cecil Shaw, M.A., illustrated by a large number of lantern pictures. The fourth meeting, an extra one, was held on the 16th January, 1890, when Mr. John Brown read a paper entitled 'Thoughts on Education and Schools.' The fifth meeting was held on the 4th February, 1890, at which a discussion took place on the 'Science and Practice of Sanitation,' opened by Professor Letts, Ph.D., who was followed by Messrs. Calwell, M.D.; Richard Patterson, J.P.; J. C. Bretland, M. Inst. C.E., City Surveyor; Conway Scott, C.E.; S. F. Milligan, M.R.I.A.; John Brown, John Lanyon, C.E.; J. Maxton, and William Gray, M.R.I.A. The sixth meeting was held on the 4th March, 1890, when three papers were read—Professor Fitzgerald, B.A., on the 'Theory of the Screw Propeller;' Mr. Robert Young, B.E., 'Some Notes on the Upper Boulder Clay near Belfast;' and Mr. H. Pearce, 'Notes on a Collection of British Butterflies presented to the Museum by the Reader,' illustrated by lantern slides. The seventh meeting was held on 1st April, 1890, when Mr. James Maxton read a paper on 'A Proposed Submerged Bridge between Ireland and Scotland,' illustrated by lime light views, diagrams, and models; after which the adjourned discussion on Professor Fitzgerald's 'Theory of the Screw Propeller' took place.

"In addition to the foregoing ordinary meetings, your Council, as usual, made arrangements for a series of popular scientific lectures. Two of them were given on the 30th and 31st October, 1889, in St. George's Hall, by Professor Douglas

Archibold, on 'Edison's Latest Phonograph,' and attracted such large audiences that two additional exhibitions of the instrument were given in the St. George's Hall and the Museum respectively. Encouraged by the success of these lectures, the services of Mr. Eadweard Muybridge were secured, who gave two lectures on 'The Science of Animal Locomotion in Relation to Design and Art,' in the Hall of the Young Men's Christian Association, on 11th and 13th February, 1890.

"It will be observed that the Hon. Treasurer, in presenting an abstract of the Accounts for the past Session, is able to congratulate the Society on a considerable increase of prosperity from a financial point of view. Members would observe that the income of the Society was larger than that of the preceding year by £38. The increase was under the heads of donations, subscriptions, visitors' fees, profit on popular lecture account, and rent from other societies. Entrance fees at Easter had decreased somewhat, owing, no doubt, to the absence of extra attractions, such as had been provided in former years. While the income had increased, the expenditure had remained at practically the same total. Some £12 less, however, had been expended in advertising, printing, and stationery and Easter expenses, and this amount had been nearly all applied to the much more desirable work of printing an extra large volume of 'Proceedings' and as a grant to the Ulster Fauna Committee. The roll of membership continued to increase, and there were no arrears of subscriptions due. The balance in hand amounted to £63 11s. 4d. This will no doubt encourage the Council of next year to consider the advisability of increasing the accommodation for members and the public, as the Lecture Room on several occasions proved insufficient to contain those anxious to be present.

"The number of societies holding their meetings in the Museum has been augmented by the addition of the Belfast Society for the Extension of University Teaching. Two of their largely attended courses were given by Mr. S. J. M'Mullen, M.A., in our Lecture Room.

"Your Council having received a memorial from Messrs. R. Patterson and R. Ll. Praeger, B.E., suggesting the advisability of supplementing the work so ably prosecuted by the late William Thompson, a former president of the Society, appointed an Ulster Fauna Committee, of which Messrs. Robert Patterson and R. Lloyd Praeger, B.E., were elected as Joint-Secretaries. They have already commenced their labours by issuing lists of birds, &c., to be filled up by those actively interested in natural history, with a view to ultimate publication.

"As has been customary on Easter Monday and Tuesday, the Museum was opened at a nominal charge, and was largely visited. The collections were supplemented by several pictures kindly lent by Messrs. R. Lloyd Patterson, J.P., F.L.S., and William Swanston, F.G.S., which, with the numerous donations of the year, were much appreciated.

"A list of the donations to the Museum and of the publications which have been received from Home and Foreign Societies with which we are in correspondence is to be printed with the present Report. Amongst the donations of special interest may be noted the Australian Emu presented by the Town Clerk on behalf of the City Corporation. This fine bird, after being stuffed and set up at the expense of the Society, by Mr. Sheals, was first exhibited at Easter, and was much admired. It is hoped that the collection of British butterflies presented by Mr. H. Pearce will induce other friends to contribute additional specimens of natural history, so as to make our local collections more complete. The Council would also desire, in this connection, to give their best thanks to the local Press for their kindness in reporting the Society's proceedings in such an admirable manner.

"Your Council now retire from office, and the meeting will be asked to select fifteen members to form the new Council."

The Hon. Treasurer submitted the Financial Statement, the principal features of which he said were embodied in the Report, therefore it was not necessary for him to make any observations upon it.

The PRESIDENT said:—The Report and Statement of Accounts are both very satisfactory. The total receipts for the year were £291, including a small balance carried over from last year. We are able to take forward now the very substantial balance of £63 11s. 4d. From this state of things I augur that next year's meetings will be even more successful than they have been in the past. The increasing popularity of the Society is no doubt largely due to the public lectures which have been given, and which have met with universal approval, and so long as the Society has a balance in hands which will enable them to increase the number of lectures they will, I think, be justified in doing so. When the lectures were first started there had to be a guarantee fund raised to cover any possible loss, but I am happy to say that, with one exception, the guarantors have never been called upon, the balance having been at all other times upon the right side. I believe that was the case, but the Hon. Treasurer will correct me if mistaken.

Mr. BROWN—The guarantors were never called upon. There was a balance on the wrong side once, but on the whole now there is a gain of a pound or two.

The PRESIDENT, continuing, said :—I am glad to know that matters are even better than I had assumed. Last year there were four lectures given, all of which were appreciated by the public, two of them, given in the St. George's Hall, particularly so. With regard to the twelve ordinary meetings of the Society which have been held, all the subjects treated were of very great importance. One of the most popular of the papers read, I think, was that of Mr. Brown on Education, and I am glad to know that it is about to be published in pamphlet form. The meeting at which the subject of Sanitation was dealt with was also an important one, and a very lively discussion took place, which indeed might have been prolonged with interest for two or three meetings had the Council seen their way to postpone it, but there were too many papers on hand to allow that to be done. Possibly next season the subject

may be re-introduced, as it is one of great importance both to scientific men and to the general public. The paper of Mr. Maxton on a submerged bridge between Ireland and Scotland was also highly interesting. Many people thought at the time that the idea was chimerical, but I notice that since the paper was read Sir E. J. Reed, formerly chief constructor to the navy, has taken out a patent for a somewhat similar plan. There may be variations of course in Sir E. J. Reed's idea from that described by Mr. Maxton, but anyhow the idea is a submerged bridge. This goes strongly to show that Mr. Maxton's proposition is not so impracticable as it is deemed by some, because, when a man of Sir E. J. Reed's position and eminence thinks it worth while to patent such a plan there must be something in it. Whether such a contrivance can ever be utilised for the conveyance of passengers is, of course, a doubtful question ; but even if it cannot, it seems quite possible, as it certainly is very desirable, that it may be used for the carriage of letters and parcels. It must be gratifying to the members of the Society to know that the public are taking a lively interest in our proceedings, and that our shares, which at one time were unsaleable, could now be placed with ease—in fact, we could place twice as many as are available for transfer. So long as the Council continues to give good value in the public lectures, and so long as the members themselves read interesting papers at the ordinary public meetings, the popularity of the Society will go on increasing. It has been suggested that the Lecture Room should be improved, and that suggestion is worthy of consideration. The Lecture Room is no doubt too small, and it might be enlarged with benefit to the Society. It must be remembered, however, that we are not a dividend-paying Society, and though, if we enlarge the room, we may be in a position to make money by letting it, we shall still be unable to return a dividend to our members. If, however, we can possibly enlarge the room it will be a very great advantage in connection with our ordinary meetings and lectures. At any rate, improve-

ments may be made in the ventilation of the room, which is at present very faulty, and I hope we have engineers enough among us to have this satisfactorily accomplished without much trouble. With regard to the Fauna Committee, I think our work will prove very useful and interesting to students of natural history. I congratulate the Council on the very successful termination of their labours, and trust that next year the Society will have an even more satisfactory record to publish.

Mr. Jaffé moved the adoption of the report and statement of accounts. He agreed with the President that the Council had done its work well, and deserved the thanks of the Society. He trusted the Lecture Room would be improved as soon as possible.

Dr. MacCormac, in seconding the motion, said he felt gratified to know that the number of the Society's members continued to increase, and that the financial position was so satisfactory. The lectures which had been given under the Society's auspices during the past season were most interesting and instructive, and calculated to develop a popular taste for scientific pursuits.

The Report was adopted.

Mr. William Gray proposed that the thanks of the Society be given to the ladies and gentlemen who had presented them with objects of interest for the Museum during the past year. He had been pleased to notice the growing tendency to make collections of the kind, and he believed that tendency had been promoted by the efficiency of the officers of the Society, and he might particularly compliment the young blood among the latter on the energy and interest displayed in the general interests of the Society.

Mr. Joseph Wright seconded the motion. There was no doubt that the collections brought together in the Museum were most valuable—indeed there was not a museum in Ireland which had so good a collection of rocks, fossils, shells, and fauna of its own neighbourhood.

The motion was carried by acclamation.

The election of the new Council was then proceeded with, Messrs. Swanston and Praeger acting as scrutineers.

While the voting papers were being distributed and collected Mr. R. M. Young, at the invitation of the Chairman, gave an interesting account of the old wooden water-pipes recently presented to the Museum. They were, he said, probably more than 200 years old, and originally formed part of a conduit and fountain which were described in "The Old Town Book of Belfast," which would shortly be published.

The President having announced the result of the election,

Mr. Thomas Workman moved, and Professor Letts seconded, a vote of thanks to Mr. Greenhill for the able manner in which he had filled the office of President during the year.

The vote was enthusiastically passed, and, the President having responded, the business terminated.

The Belfast Natural History and Philosophical Society in Account with Hon. Treasurer For the Year ending April 30th, 1890.

Dr. **Cr.**

EXPENDITURE.

	£	s.	d.
To Cash paid Insurance Premiums	£6	12	0
,, Printing and Stationery	9	15	8
,, Printing Report and Proceedings	18	2	9
,, Advertising	10	9	0
,, Collector's Commission	5	18	10
,, Water Rate	2	4	7
,, Hire of Optical Lantern	1	0	0
,, Purchase of Shares bought in	1	10	0
,, Fuel and Gas	13	11	11
,, Carriage, Postage, Telegrams, etc.	5	14	4½
,, Expenses at Easter	8	13	1
,, Repairs, etc.	5	9	9
,, Ironwork and Painting on Armourplate	3	4	7
,, Stuffing Emu	5	0	0
,, Grant to Ulster Fauna Committee	5	0	0
,, Wm. Darragh, Salary till April 30th	48	0	0
,, S. A. Stewart, ,, ,, less one week's leave	49	0	0
,, S. A. Stewart, Gratuity	3	3	0
,, Rent till April 30th	25	0	0
To Balance	63	11	4
	£291	0	10½

RECEIPTS.

	£	s.	d.
By Balance in Hon. Treasurer's hands	£8	13	11
,, Interest on Deposit with York St. Spinning Co.	19	10	1
,, Copy of Proceedings sold	0	2	0
,, Transfer Fees	1	10	0
,, Donations	32	0	0
,, Subscriptions	126	8	0
,, Do. Arrears	2	10	0
,, Profit on Lecture Account	2	16	7
,, Entrance Fees at Door till April 30	22	15	3
,, Do. Easter Monday	35	5	8½
,, Do. Easter Tuesday	6	7	10
,, Contribution from Naturalists' Field Club	5	5	0
,, Do. Ulster Amateur Photo. Society	4	4	0
,, Do. Society for Extension of University Teaching	8	12	6
,, Do. Ulster Medical Society	15	0	0
	£291	0	10½
By Balance in Hon. Treasurer's hands	£63	11	4

Examined and found correct.

SAMUEL ANDREWS,
WM. H. PATTERSON, } *Auditors.*

J. BROWN, *Hon. Treasurer.*

DONATIONS TO THE MUSEUM, 1889-1890.

From Mr. M'Kibbin, Melbourne.

A number of insects from Victoria.

From Messrs. H. & J. Martin.

Two wooden water pipes, dug up in Donegall Place.

From Thomas Workman, Esq., J.P.

A nest of the trapdoor spider from Natal.

From R. Lloyd Patterson, Esq., J.P.

Coloured plate of the Irish rat (*mus hibernicus*).

From Otto Jaffé, Esq.

A portion of stucco from an ancient wall in Toledo.

From W. Swanston, Esq., F.G.S.

A handled crucible found at the cranoges in Lough Mourne.

From John Brown, Esq.

Specimens of granite from Slieve Lanagan, showing micro-crystals of quartz, &c.

From J. R. Macoun, Esq.

Prepared head of a crocodile and dried skin of another crocodile.

From Miss Mackay, Fortwilliam.

Several old books.

From Miss Lanyon.

Thirty-nine plaster casts of medallions.

From Some Members of the Council.

A stuffed specimen of the buff-breasted sandpiper.

From Mr. W. Darragh.

Two specimens of Pallas's sand grouse shot in County Down.

From Orr M'Causland, Esq.

Four flint arrow heads from Nebraska.

From John Rogers, Esq.

A stuffed specimen of the South American alligator.

From R. M. Young, Esq.

A wrought flint celt, a flint core, and flint knife from the implement gravels at the Curran of Larne, also a specimen of tourmaline from the Mourne Mountains.

From Mr. John Morrison, Ligoniel.

A complimentary address in Hindustani writing, presented to Major Abbott by the inhabitants of Delhi in 1857.

From Captain Robert Campbell. of the ship Slieve Donard.

A spear from the palace of Mandalay, a dacoit's spear, a sword from Mandalay, an Autralian wooden spear, a nest and eggs of the tailor bird, several nests of the yellow-capped weaver bird, a flying fish, snake, skin of cobra, &c.

From Dr. M'Kee.

A collection of fossils, mainly carboniferous.

From ——— ———.

Diploma and album, with memorials of the late Dr. James M'Knight, of Londonderry.

From W. Patterson, Esq.

A specimen of the common viper in spirits.

From Sidney Plunkett, Esq.

Feathers of tropic bird from South Seas.

From W. H. Phillips, Esq.

Specimen of wood showing the mistletoe growing on apple tree.

From Herbert Pearce, Esq.

A collection of British butterflies.

From ——— ———.

Specimen of mountain cork, &c., from the Cave Hill, and a fossil coral from Lough Neagh.

From The Misses Matier.

Fine specimen of chalcedony from Carnmoney, and specimens of kidney iron ore.

From Dr. Gawn Orr, Ballylesson.

Bones from an ancient burial cyst recently discovered at the Giant's Ring.

From Robert Whitfield, Esq.

A mammoth's tooth from Mexico.

From W. M'Cammond, Esq., J.P.

Wooden pipes from Fountain Street.

ADDITIONS TO THE LIBRARY, 1st MAY, 1889, TILL 1st MAY, 1890.

ADELAIDE.—Transactions and Proceedings of the Royal Society of South Australia, Vol. 11, 1887-8.
From the Society.

BELFAST.—Proceedings of the Belfast Naturalists' Field Club. Ser. 2, vol. 3, parts 2 and 3, 1888-9 and 1889-90.
The Club.

BERGEN.—Bergens Museums Aarsberetning for 1888.
The Museum.

BERLIN.—Verhandlungen der Gesellschaft für Erdkunde. Vol. 16, parts 4-10, 1889; and vol, 17, parts 1-3, 1890. *The Society.*

BIRMINGHAM.—Proceedings of the Birmingham Philosophical Society. Vol. 6, part 1, 1887-8; and part 2, 1888-9. *The Society.*

BOLOGNA.—Rendiconto delle sessioni Della R. Accademia delle Scienze Dell Instituto di Bologna. Anno 1887-8 and 1888-9. *The Academy.*

BOSTON, U.S.A.—Proceedings of the Boston Society of Natural History. Vol. 23, parts 3 and 4, 1886-8.
The Society.

BREMEN.—Abhandlungen Herausgegeben vom Naturwissenschaftlichen zu Bremen. Vol. 10, part 2, 1889.
The Society.

BRESLAU.—Zeitschrift für Entomologie, Herausgegeben vom Verein für Schlessiche Insektenkunde zu Breslau. New series, part 14, 1889.
The Society.

BRUSSELS.—Bulletin de la Société Royale de Botanique de Belgique. Vol. 28, 1889. *The Society.*

Comptes Rendus des seances de la Societe Entomologique de Belgique. Ser. 3, Nos. 117-120, 1889. *The Society.*

Annales de la Société Royale Malacologique de Belgique. Vol. 23, 1888; and Proces Verbaux des Seances, 1st July, 1888, to 1st July, 1889. *The Society.*

CALCUTTA.—Records of the Geological Survey of India. Vol. 22, parts 2-4, 1889; and vol. 23, part 1, 1890.

Memoirs (Palæontoligica Indica). Ser. 13, vol. 4, part 1, 1889. *The Director of the Survey.*

CAMBRIDGE, U.S.A.—Bulletin of the Museum of Comparative Zoology. Vol. 16, parts 4-7; vol. 17, parts 3-6; vol. 18, 1889; and vol. 19, No. 1, 1890; also Annual Report of the Curator, for 1888-9. *The Curator.*

CARDIFF.—Report and Transactions of the Cardiff Naturalists' Society. Vol. 20, part 2, 1888; and vol. 21, part 1, 1889. *The Society.*

CASSEL.—Bericht des Vereines für Naturkunde zu Cassel, 1886-8. *The Society.*

CORDOVA (Argentine Republic).—Boletin de la Academia Nacional de Ciencias en Cordoba. Vol. 10, part 3; and vol. 11, part 3, 1888-9. *The Academy.*

CHRISTIANIA.—Forhandlinger i Videnskabs Selskabet i Christiania, 13 parts, and Ofversigt, 1888. *The University.*

Forhandlinger ved de Skandinaviske Naturforskeres, 1886. *The Society.*

Silurfossiler og Pressede Konglomerater i Bergensskiffrene, 1882; and Om Humanisten og Satiriken Johan Lauremberg, 1884. *The University.*

DANTZIC.—Schriften der Naturforschenden Gesellschaft in Dantzig. Vol. 7, part 2, 1889. *The Society.*

DAVENPORT, IOWA.—Proceedings of the Davenport Academy of Natural Sciences. Vol. 5, part 1, 1884-9.
The Academy.

DUBLIN.—Transactions of the Royal Society. Ser. 2, vol. 4, parts 2-5, 1889. Proceedings (N.S.), vol. 6, parts 4-6, 1888-9. *The Society.*

EDINBURGH.—Proceedings of the Botanical Society of Edinburgh. Vol. 17, part 2, 1888, and part 3, 1889. *The Society.*

Reports of the Laboratory of the Royal College of Physicians, Edinburgh. Vol. 2, 1890.
The College.

Proceedings of the Royal Physical Society. Vol. 9, part 3, 1887-8; and vol. 10, part 1, 1888-9.
The Society.

ESSEX.—The Essex Naturalist. Vol. 3, Nos. 1-9, 1889.
The Essex Field Club.

FLORENCE.—Bullettino della Societa Eutomologica Italiana. Anno 20, parts. *The Society.*

GENOA.—Ateneo Ligure Rassegna Mensile della Societa di Letture, 4 parts, anno 12, 1889. *The Society.*

GLASGOW.—Proceedings of the Natural History Society of Glasgow. New series, vol. 2, part 2, 1887-8.
The Society.

Proceedings of the Philosophical Society of Glasgow. Vol. 20, 1889. *The Society.*

HALIFAX (Nova Scotia).—Proceedings of the Nova Scotian Institute of Natural Science. Vol. 1, part 4; vol. 2, parts 1-4; vol. 4. parts 1, 3, and 4; vol. 5, parts 1-4; vol. 6, parts 1-4; vol. 7, parts 1 and 2; 1864 till 1888. *The Institute.*

HAMBURG.—Abhandlungen aus dem Gebiete der Naturwissenschaften herausgegeben vom Naturwissenschaftlichen Verein in Hamburg. Vol. 11, part 1, 1889. *The Society.*

IGLO (Austria-Hungary).—Jahrbuch des Ungarischen Karpathen-Vereines. 16th year, 1889. *The Society.*

KIEW.—Memoirs of the Society of Naturalists of Kiew. Vol. 10, part 2, 1889. *The Society.*

LAUSANNE.—Bulletin de la Societe Vaudoise des Sciences Naturelles. Vol. 24, No. 99; and vol. 25, No. 100. *The Society.*

LIVERPOOL.—Proceedings of the Literary and Philosophical Society of Liverpool. Vol. 41. 1886-7; vol. 42, 1887-8; and vol. 43, 1888-9. *The Society.*

LONDON.—Quarterly Journal of the Geological Society. Vol. 45, parts 2-4, 1889; vol. 46, part 1, 1820; and List of Fellows of the Society, 1889. *The Society.*

Journal of the Royal Microscopical Society, Nos. 70-73, 1889, and Index; also Nos. 74 and 75, 1890. *The Society.*

Proceedings of the Zoological Society of London. Parts 2, 3, and 4, 1889. *The Society.*

MANCHESTER.—Transactions of the Manchester Geological Society. Vol. 20, parts 5 and 6, and 8-13, 1889; also parts 14-17, 1890. *The Society.*

MELBOURNE.—Proceedings of the Royal Society of Victoria. New series, vol. 1, 1882. *The Society.*

MERIDEN (Conn. U.S.A.).—Transactions of the Meriden Scientific Association. Vol. 3, 1887-8. *The Association.*

MEXICO.—Anuario del Observatorio Astronomico Nacional de Tacubaya. Ano 10. *The Director.*

MILWAUKEE.—Occasional Papers of the Natural History Society of Wisconsin. Vol. 1, 1889; and Proceedings, 1888-9. *The Society.*

Milwaukee Public Museum, 7th Annual Report, 1889. *The Museum.*

MINNEAPOLIS.—Sixteenth Annual Report of the Geological and Natural History Survey of Minnesota, 1888.
The State Geologist.

MOSCOW.—Bulletin de la Societe Imperiale des Naturalistes de Moscow, No. 4, 1888 ; Nos. 1-3, 1889. Meteorologische Beobachtungen, part 2, 1888 ; and part 1, 1889 ; also Nouveaus Memoires, vol. 15, part 6, 1889. *The Society.*

NEW YORK.—Annals of the New York Academy of Sciences. Vol. 4, Nos. 10 and 11, 1889. *The Academy.*

Bulletin of the American Geographical Society. Vol. 21, Nos. 1-4, and Supplement, 1889 ; and vol. 22, No. 1, 1890. *The Society.*

ODESSA.—Memoirs of the Society of Naturalists of New Russia. Vol. 14, part 1, 1889. *The Society.*

OTTAWA.—Annual Reports of the Geological and Natural History Survey of Canada. New series, vol. 3, parts 1 and 2, and Maps, Nos. 2-14 ; also No. 17, and Plan of Asbestos Area, and Contributions to Canadian Palæntology, vol. 1, part 2, 1889. *The Director of the Survey.*

PADUA.—Bullettino della Societa Veneto-Trentina di Scienze Naturali. Vol. 4, No. 3, 1889.
The Society.

PHILADELPHIA.—Proceedings of the Academy of Natural Sciences. Part 3, 1888; and parts 1 and 2, 1889. *The Academy.*

PISA.—Atti della Societa Toscano, Processe Verbali. Vol. 6, 3 parts, and vol. 7, 1 part, 1889 ; also Memoir of Prof. Meneghini. *The Society.*

ROME.—Atti della Reale Accademia dei Lincei. Ser. 4, vol. 5, 1st semestre, fasc 4-12 ; 2nd semestre, fasc 1-13, 1889 ; and vol. 6, 1st semestre, fasc 1-4, 1890.
The Academy.

Journal of the British and American Archæological Society of Rome, 1888-9. *The Society.*

San Francisco.—Proceedings of the California Academy of Sciences.

Santiago de Chile.—Verhandlungen des Deutschen Wissenschaftlichen Vereines zu Santiago. Vol. 2, part 1, 1889. *The Society.*

Stirling.—Transactions of the Stirling Natural History and Archæological Society, 1888-9. *The Society.*

Stockholm.—Kongliga Svenska Vetenskaps Akademiens Handlingar. Vols. 20 and 21, 1882-85.

Bihang till Kongl Vetenskaps Akademiens Hand lingar. Vols. 9-13, 1884-88; Ofversigt, vols. 41-5, 1884-8; and Lefnadsteckningar, vol. 2, part 3. 1885; also Atlas of Salmonidæ, 1887. *The Swedish Royal Academy.*

Topeka (Kansas).—Transactions of the Kansas Academy of Science. Vol. 10, 1885-6; and vol. 11, 1887-8. *The Academy.*

Toronto.—Proceedings of the Canadian Institute. Series 3, vol. 6, fasc. 2, and vol. 7. fasc. 1, 1889; also Annual Report, 1889. *The Institute.*

Trenton, N.J.—Journal of the Trenton Natural History Society. Vol. 2, No. 1, 1889. *The Society.*

Trieste.—Bollettino delle Societa Adriatica di Scienze Naturali. Vol. 12, 1890. *The Society.*

Venice.—Notarisia Commentarium Phycologicum, parts 14-17, 1889; and General Index for 1886-8. *The Editor.*

Vienna.—Verhandlungen der Kaiserlich-Koniglichen Zoologisch-Botanischen Gesellschaft in Wien. Vol. 39, parts 1-4, 1889. *The Society.*

Verhandlungen der Kaiserlich-Koniglichen Geologischen Reichsanstalt, Nos. 4-6, and 9-18, 1889; and Nos. 1-5, 1890. *The Society.*

WASHINGTON.—U.S. Department of Agriculture, Division of Economic Ornithology and Mammology. Bulletin 1, The English Sparrow, 1889. *The Department.*

Bulletin of the United States National Museum, Nos. 33-37, 1889; and Proceedings of the U.S. National Museum, vols. 10, 1887, and 11, 1888. *The Museum.*

Annual Report of the Smithsonian Institution, 1886, part 1. *The Institution.*

YORK.—Annual Reports of the Yorkshire Philosophical Society for 1888 and 1889. *The Society.*

From JOHN BROWN, Esq., Belfast.—Musical Sand, a pamphlet, 1888.

From DR. RICKETTS, F.G.S., Liverpool.—Changes in the Earth's Crust, a pamphlet.

From DR. SCHARFF, Dublin.—More's List of Irish Birds.

BELFAST

NATURAL HISTORY & PHILOSOPHICAL SOCIETY

SESSION 1889-90.

5th November, 1889.

PROFESSOR E. A. LETTS, PH.D., F.R.S.E., F.C.S., in the Chair.

J. H. GREENHILL, Esq., Mus. Bac., T.C.D., (the President of the Society), read a Paper on WORK.

THE LECTURER said :—When elected President of the Natural History and Philosophical Society for the ensuing year, I realised how difficult it would be to do justice to the position, bearing in mind the names of those who had been similarly honoured, more especially that of my immediate predecessor, Professor Letts, who on various occasions had favoured us with such instructive and charming lectures. I also felt that there were members who were more entitled to be elected than I was, particularly one gentleman who had already distinguished himself by original research, and to whom, in connection with their Hon. Secretary, Mr. Young, the Society owes much of its present popularity : I refer to Mr. J. Brown. Another difficulty with me was in connection with the inaugural address, partly arising from the fact that two subjects with which I am more acquainted than with others, namely, electricity and music, had been already treated by me in papers read before the Society. I had therefore to think of something else which would possibly prove of some interest to the members, and which came within my ability to expound, and, believing that the various forms of mechanical and

chemical energy offered a wide field from which I could select some subjects for consideration, "Work" is what I have decided upon.

If nine people out of ten were asked what is the meaning of the term they would probably answer "The act of doing something;" but if we turn to text books for a definition we get more complex explanations, such for instance as "In all cases where force is employed in overcoming resistance so as to produce motion work is said to be performed." In any case work is what we are all engaged in—some perhaps from the love of investigation and invention, others from sheer necessity of keeping body and soul together; a section in order to amass riches, and not a few who work the hardest in trying to amuse themselves, without a thought of whether they are fulfilling the mission for which all of us have been sent on earth—namely, to benefit our neighbours, and leave the world, if not the better, certainly nothing the worse for our presence in it.

The standard mechanical unit of work is the "foot pound," that is the effect capable of being produced by one pound weight falling a distance of one foot. In the capacity for doing work time is an important factor. For instance, the well-known standard of one-horse power is the force or power which is required to raise 33,000 lb. (nearly $14\frac{3}{4}$ tons) one foot high in one minute. These conditions are interchangeable, so that if one-tenth of this weight is raised ten feet high in the same period, or if 330 lbs. are raised ten feet in one-tenth of a minute, the same power is necessary.

Referring to the question how the ancients were able to raise the heavy masses of stones to form their cromlechs, as they had so few mechanical appliances, the lecturer showedby experiments that without rolling the stones up an inclined plane, or even employing a lever, the huge masses could be "rocked" or oscillated up by degrees. Later on he gave an example of the great effects produced by the hydraulic jack, by breaking heavy bars of iron, and described the various forms of water-

wheels, including two fine specimens of the "Fourneyron" turbine, kindly lent by Mr. Macadam and Mr. Bell, of the Soho Foundry. He showed the crude principle of the steam engine by a long brass tube in which steam was generated, and subsequently condensed, causing a piston to move up and down. The compound and triple expansion types of steam engines, with surface condensers, were explained, and also the theory of the gas engine, by exploding in the same brass tube mixtures of gas and air. The relative efficiencies of steam and gas engines were stated, showing that in recent trials carried out by the Society of Arts a steam engine, working with a boiler pressure of 191 lb. above the atmosphere, and using 1.9 lb. of coals for each indicated horse-power per hour, the efficiency of the engine and boiler only represented 9·6 per cent., showing a loss of over 90 per cent. in the theoretical value of thermal units which the coal possessed. Gas engines have a much higher percentage of efficiency, showing a return of 22·8 per cent. It is said that about 50 per cent. of the theoretical power contained in gas is lost in the exhaust of the engine, and about 27 per cent. is wasted in the water jacket surrounding the cylinder. The lecturer indicated that in large engines steam is more economical, owing to the fact that the fuel is less costly, considering the thermal units in coal, but in small ones the balance is in favour of gas. Highly satisfactory results are reported, so far as economy of working is concerned, when Dowson's gas is used. The mode of indicating what power an engine is developing was shown both by diagrams and the friction brake.

Passing allusion was made to the energy contained in 1 lb. of gunpowder, showing it contains less energy than an equal weight of coal,* and also to the muzzle velocity of heavy cannon balls; and after expressing his thanks to Mr. Workman, who had kindly lent a beautiful little gas engine, which, with the other class of motors, was at work, and to Messrs. R. Patterson & Sons and Mr. W. T. Coates for various articles lent for the experiments, the lecturer went on to say that "the sun is the

*Experiments go to prove that gunpowder only contains about *one-twelfth* the energy contained in an equal weight of coal.

material source of energy by which all kinds of work in this world are performed. By his mighty agency in prehistoric times those vast masses of vegetation, which we now recover as coal, were formed, upon which we now so largely depend for the generation of power. Without his aid all animal and vegetable life would cease to exist. Under his influence those atmospheric changes occur which produce the wind and cause the clouds to form, from which the rivers and lakes receive their supply. Day by day we are advancing in the development of the resources which nature has placed at our disposal, and day by day we are attaining far higher results, with a less percentage of so called "loss," though we know that what appears lost to us is merely a change of condition. Who can tell but that in the future, mankind shall benefit by that mysterious agency of which we know so comparatively little, and only so far as to guard ourselves against its destructive capabilities ? — namely, atmospheric electricity.

"If we look back even for a hundred years, and contemplate the crude appliances which were then considered marvels, and compare them with the discoveries of the present day, and then allow our fancies to travel forward to the year 1989, and try to imagine what shall then be known in the various branches of science, it makes us almost feel that with all we have learned we are not much more than on the threshold of what the future will reveal to our successors."

During the discourse a number of interesting experiments were performed by the lecturer, amongst them being the breaking of a bar of cast iron four inches square by a small hydraulic jack lent by Messrs. Tangye, Birmingham, already referred to, and the working of beautiful models of steam engines and water wheels.

3rd December, 1889.

J. H. Greenhill, Esq., Mus. Bac., in the Chair.

John Vinycomb, Esq., read a paper entitled

SOME REMARKS ON DEAN SWIFT'S AUTOGRAPH, AND THE SEAL OF THE DEANERY OF ST. PATRICK'S, DUBLIN.

The Lecturer stated that the seal in question appears to have been appended to a parchment deed, but has been cut off by some reckless autograph hunter for the sake of the signature. Considering, perhaps, that all the legal responsibilities referred to by the document are at an end, they are obsolete and of no account, and the only thing worth preserving is the seal and autograph of the celebrated Dean of St. Patrick's, whom everybody has heard of. A small portion of the bottom part of the sheet or skin remains, through which the attachments of the seal were interlaced before sealing, and the name written across the two portions in the usual manner. Mr. Vinycomb then gave an interesting description of the seal, which was impressed upon the paper over a moistened wafer, of which several examples were shown, a fashion which was introduced about the close of the sixteenth century.

John Brown, Esq., read

NOTES ON THE MUSICAL SAND OF EIGG.

Some attention has recently been drawn to the occurrence of "Musical Sand" in various localities. Its existence has

been alluded to sparingly through the writings of a thousand years, and it is known to exist in two localities in the East—viz., *Gebel Nakus*, or the "Mountain of the Bell," near the Red Sea; and *Reg Ruan*, or the "Moving Sand," forty miles north of Cabul. It was discovered in Eigg, a picturesque islet off the West Coast of Scotland, by Hugh Miller, in 1850. Mr. Miller has written of it—"I struck it obliquely with my foot where the surface lay dry and incoherent in the sun, and the sound elicited was a shrill sonorous note, somewhat resembling that produced by a waxed thread when tightened between the teeth and the hand, and tipped by the nail of the forefinger."

I visited the place while cruising on the West Coast in 1878, and found the sand as described by Miller, but I thought the sound more like a kind of whistling noise, rather resembling that made by quickly drawing one piece of *gros grain* silk over another. It is quite distinct from the neighbouring beds of ordinary sand. I brought away some, a portion of which I now present to the Society, together with a copy of the paper by Mr. Wilson, mentioned below. The sand is now "mute," all musical sand becoming so when handled or soiled. Mr. Carus Wilson, F.G.S., Bournemouth, in a paper published last year, mentioned numerous localities now known where more or less musical sand occurs, but described the Eigg sand as the most musical he knew of. Mr. Wilson attributed the sonorous qualities to smoothness of surface of the particles, uniformity in their size, and freedom from fine dust adhering to them. Under the microscope the Eigg sand appears as particles of perfectly clear rock crystal. Mr. Carus Wilson has endeavoured to manufacture artificial musical sand on his theory, but only with a moderate approach towards a successful imitation of the natural product.

SEATON F. MILLIGAN, Esq., read a Paper entitled

WITH THE ROYAL HISTORICAL AND ARCHÆOLOGICAL SOCIETY AT LIMERICK.

RECENT ANTIQUARIAN EXPLORATIONS, WITH SPECIAL REFERENCE TO THE ANCIENT IRISH HOT-AIR BATH.

NOTES ON A CARVED-OAK TUDOR PANEL.

ON Tuesday, 16th July, a small party of members of the Royal Historical and Archæological Society from Ulster, consisting of one lady and four gentlemen, proceeded to Dublin, and from thence to Limerick, to take part in the proceedings at the Summer Meeting of the Society. Three of these were from Belfast, one from Enniskillen, and one from Omagh. We arrived on Wednesday 17th, at 1.30, and had just time, after depositing our things at the hotel, to reach the Athenæum, where the opening meeting was to be held, at two o'clock. Lord James Butler, the President of the Society, had not arrived, owing to an unforeseen detention of the train, and the chair was taken, in his absence, by Mr. Maurice Lenahan, J.P., Vice-President, a venerable old gentleman, and well known as the author of a most valuable history of the city of Limerick. After a short meeting, at which a few unimportant papers were read, we adjourned till eight o'clock p.m. Meantime, it was arranged we should proceed to the Cathedral of St. Mary's, the Dean having consented to show us over the building and explain many interesting details concerning the sacred edifice.

St. Mary's, which is now the Protestant Cathedral of Limerick, was founded by Donald More O'Brien, King of Thomond, in the year 1179. It is a plain Gothic building of massive appearance, with many historical associations. The exterior is in fairly good repair, but the interior has a rather neglected look. It contains many interesting memorials of the past, amongst which is the carved lid of a stone coffin of King Donald; also, the tomb of Bishop Donal O'Brien, dated 1217,

and the tomb of Bishop O'Dea, dated 1427. I should here state that the mitre and crozier of Bishop O'Dea were shown in the Athenæum, together with many other relics, by the kind permission of the Most Rev. Dr. Dwyer, Roman Catholic Bishop of Limerick. The crozier, of silver, studded with precious stones, is about 6 feet 6 inches high, and separates into three parts, which are easily joined together. The mitre is studded with pearls and precious stones. Both are gems of art in there way. There are also life-sized effigies in the cathedral near the high altar of Donagh O'Brien and Elizabeth, his wife, daughter of the eleventh Earl of Kildare, dated 1624. I also noted a simple stone tablet with the following inscription, without a date:—"Sacred to the memory of Dan Hayes, an honest man, and a lover of his country." An old house now occupied as a tenement house, adjoins the cathedral yard, in which Ireton, Cromwell's son-in-law, died of the plague.

Limerick consists of an old town and a new. The cathedral stands in the old town. There are many ancient frame houses, dating before the siege, now occupied as tenement houses. The Corporation is endeavouring to provide better accommodation for the poor, as their present dwellings are in many instances very dilapidated. In the old town, near to the cathedral, at the end of Thomond Bridge, stands King John's Castle, built in 1210, and still occupied as a military barrack. It is a massive quadrangular Norman castle, with circular towers at the angles. It is still quite perfect, with the exception of a few spots where the Cromwellian and Williamite cannon displaced the stones, which have been since replaced by red brick, which show at a glance the damages it then sustained. On the opposite side of the bridge is the treaty stone, placed on a pedestal. Near the cathedral, and within the grounds of a convent, we examined the ruins of a Dominican Abbey. Within the grounds of another convent a portion of the ancient city wall may be seen, showing considerable damages from a Cromwellian battery which commanded it from a hill opposite. We next proceeded to St. John's Chapel, which is the principal

Roman Catholic Chapel in the city. It is adorned with the highest and finest steeple I have seen in Ireland. The interior is richly furnished, and the windows are all of stained glass. A few of our party drove out to Mungret Abbey, a distance of three miles from the city. There are ruins of an ancient church of the sixth century, an oratory of so-called cyclopean masonry dating from the seventh or eighth century, and the monastic buildings and square tower ranging in date down to the fourteenth century. There is a collegiate school at Mungret at present, where students are prepared for the Universities. Limerick owes its origin to the Danes, who built a stronghold in an island near to where the cathedral now stands, and their kings ruled over it and the surrounding district for over 200 years. The Shannon is a noble river at Limerick, and adds greatly to the beauty of the city. Thackeray's description of what it was half a century ago is worth repeating: "They say there are three towns to make one Limerick; there is the Irish town on the Clare side; the English town, with its old castle, which has sustained a deal of battering from Danes, from fierce Irish kings, from English warriors who took an interest in the place, Henry Secundians, Elizabethians, Cromwellians, and *vice versa*, Jacobites, King Williamites, and nearly escaped being in the hands of the Robert Emmettites; and finally the district called Newton-Pery. In walking through this latter you are at first half led to believe that you are arrived in a second Liverpool, so tall are the warehouses and broad the quays, so neat and trim a street of nearly a mile which stretches before you. But even this mile-long street does not in a few minutes appear so wealthy and prosperous as it shows at first glance, for, of the population that throng the streets, two-fifths are barefooted women and two-fifths more ragged men; and the most part of the shops, which have a grand show with them, appear, when looked into, to be no better than they should be, being empty, make-shift looking places, with their best goods outside." This description would not hold good to-day, as the barefooted, ragged people have to a great extent

disappeared, and the shops are fairly good and well stocked. Thackeray further says, "If the ladies are pretty, indeed the vulgar are scarcely less so. I never saw a greater number of kind, pleasing, clever-looking faces among any set of people." Limerick, like many other southern towns, would be greatly benefited by a further extension of employment for the people. The industries are few, and not sufficiently diversified. America, no doubt, has absorbed the bulk of the people described by Thackeray, as there is no other resource for them if employment is not to be found at home.

Our excursion on Thursday, 18th, was by special train to Askeaton and Adare and back. We left Limerick at 10 a.m., and after an hour's run we reached Askeaton. Here we examined the remains of an ancient castle, built by James, seventh Earl of Desmond, in the first quarter of the fifteenth century. It is situated in a rock above the level of the adjacent ground. The square tower of the castle still stands to a height of 90 feet, close by is the banqueting hall, underneath the vaulted floor of which were the kitchens, now used as a cowhouse. The marks of wattle work on the vaulted ceiling are still very distinct. Situated beside the castle, on the lower ground, is a house which was well known in the last century as the "Hell-fire Club," whose members gained this unenviable title by their midnight orgies and disreputable conduct. We next proceeded to the ruins of the Franciscan Abbey founded by the same James, seventh Earl of Desmond, in 1420. Its present dilapidated condition is principally due to the injuries it sustained by Melby's troops in 1579. They blew up the walls with gunpowder, and so firmly cemented were they that they still lie as they fell in large and solid masses. Notwithstanding the ravages of war and time, this fine old ruin is still most interesting. The cloisters are perfect with the exception of one column, said to have been stolen by a Frenchman about eighty years ago, who brought it to his own country to copy, the design being considered strikingly beautiful. A river flows past the abbey and through the centre of the town, where

it is spanned by a very antique bridge. Abbeys are usually situate beside a stream, which served the double purpose of supplying fish and driving the mill wheel, as the monks very frequently ground the grain for the people at a time that querns were principally used for that purpose.

After we had fully explored the ruins of the castle and abbey and listened to a paper which was read by one of the members on the history of the place, we proceeded to Adare. It is a most beautiful and picturesque village, situate close to the residence and demesne of Lord Dunraven. Gerald Griffin writes of Adare—

> "Oh, sweet Adare, oh, lovely vale,
> Oh, soft retreat of sylvan splendour;
> Nor summer's sun, nor morning gale,
> E'er hailed a scene more softly tender."

There are remains of three abbeys at Adare, two in the village —viz., the Trinitarian and Augustinian—and another within the grounds of Lord Dunraven—viz., the Franciscan, one of the finest in Ireland. The late Lord Dunraven restored the churches of the two abbeys in the village, and they are now used for worship, the Trinitarian by the Roman Catholics, and the Augustinian by the Protestants. The remains of the Franciscan Abbey are most complete, owing to the care bestowed on it by his Lordship. The walls are all in a fair state of repair, only wanting a roof to make them almost habitable again. Very few small towns in Ireland could boast of three abbeys, but under the fostering care of the Kildare branch of the Geraldines these three abbeys were once renowned and flourishing institutions. The Trinitarian order was introduced into Ireland in the year 1230. Their mission was the redemption of captives. It is recorded that they rescued 6,300 persons from slavery, principally Christians captured by the Turks. For this purpose ladies gave their jewels and noblemen their plate to pay the ransom. The Franciscan Abbey, situated on the banks of the silvery Maigne, was founded by Thomas, seventh Earl of Kildare, and Joanna, his wife,

daughter of James, Earl of Desmond, who laid its first stone in 1464. Close to the ruins of this abbey are the remains of a strong castle built by the Kildare branch of the Fitzgeralds, who owned extensive estates about Adare.

We next proceeded to the residence of Lord Dunraven, where the collection of paintings, antiquities, and art treasures were thrown open for inspection. The entrance hall, library, and picture gallery are the prominent features of the house. The hall is decorated with coats of mail and ancient armour; also skeletons of the Irish elk. In addition to a fine collection of paintings, the picture gallery is adorned with some rare carvings of cabinets and panels collected on the Continent. In the grounds and convenient to the house there is a collection of those curious inscribed stones called Oghams. These were collected by the late lord, whose remains lie in a vault close by the Agustinian Church. The following inscription is placed over the entrance to the vault:—" My son, remember now thy Creator in the days of thy youth." The party were shown through the Augustinian Church by the Rev. Mr. O'Brien, the rector, son of the late William Smith O'Brien, and afterwards through the Trinitarian Chapel by the Rev. Mr. Flanigan, the parish priest.

On Friday we started by special train to Killaloe, a most picturesque town, built on the Shannon, which is here crossed by a fine bridge. The principal object of interest is the cathedral, built in 1160, on the foundation of a still older church. Divine service is still held in this venerable building. A fine Romanesque doorway is one of the greatest objects of interest in the cathedral. Petrie refers to it as follows:—" That the cathedral is not of Brian's time is, however, sufficiently obvious from its architectural details, which clearly belong to the close of the twelfth century; and its re-erection is attributed with every appearance of truth to Donald Mor O'Brien, King of Limerick, who died in the year 1194. Yet that a more ancient church, and one of considerable splendour, had previously existed on its site, is evident from a semicircular

archway in the south wall of the nave, now built up, and which is remarkable for the richness of its embellishments in the Romanesque or Norman style. Close to the cathedral is a small stone-roofed church or oratory of a much earlier date—it is a building similar to St. Columb's house at Kells and St. Kevin's kitchen at Glendalough."

At Killaloe was Kincora, the palace of Brian Boru. A little way above the town, at the entrance to Lough Derg, there is a great earthen fort or rath, now called Kincora. This fort was an important stronghold in Brian's time, as it commanded the river at this point, and protected the Royal residence farther down the river. It was from here that Brian started with his brave army to Clontarf. The tradition in the locality states that they sailed up the Shannon in coıachs as far as Athlone, from whence they marched to Clontarf.

Our party proceeded by steamer to Inis Caltra, or Holy Island. There is a round tower on the island, and the ruins of seven churches. The principal church, said to have been restored by Brian, is close beside the round tower. The view from the lake is particularly fine. We see around us the hills of Clare, Tipperary, and Galway, and the fine expanse of water formed by the Shannon on its way to the sea. The grey old tower and ancient church, with groups of peasants in their picturesque costume, complete a picture tending to produce a solemn and religious feeling on the mind. The literal meaning of Inis Caltra is the island burying-place. Inside the principal church the floor and walls are covered with incised crosses of most beautiful designs, whilst the graveyard outside has some very ancient tombs, closely bordering on the Pagan type. The masonry of the church, with the exception of a portion on the eastern side, supposed to have been added by Brian, is precisely of the same stone and workmanship as the round tower. There could not be a more convincing proof of the Christian origin of the round towers than to compare closely the workmanship in the tower and the church on Inis Caltra.

We returned to Limerick in time for our evening meeting,

which was largely attended, as well as all the other meetings held there. Dr. Söderberg, principal of the Museum at Lund, in Sweden, attended our meetings at the request of the King of Sweden, to report on our antiquities and other matters. For this purpose he visited the museum of the Royal Irish Academy, the museum at Belfast, and several private collections, including the Rev. Canon Grainger's, Mr. Day's, of Cork, and others. There was a paper read on the "Danes of Limerick," at which Dr. Söderberg was present, and he listened with great interest to the tales of devastation and ravages committed in the South of Ireland by his ancestors. He replied in fairly good English, and added that there are many interesting relics of Ireland in his country, including some manuscripts, no doubt a portion of the plunder in those ancient times.

On Saturday a small party turned up for our last excursion to the historic town of Kilmallock. It is situated in the south of the County Limerick, 42 miles distant from Cork. Though an insignificant town now, it was a place of very great importance in the Elizabethan age. It was a walled town, and Queen Elizabeth's representative, the President of Munster, lived here. A considerable portion of the old wall is still standing, outside of which is a deep and wide fosse still filled with water. One of the old gates still stands, surmounted by a watch tower, to which access is obtained by a small winding stone staircase. From the top of this tower a fine view of the surrounding country is obtained for several miles around. The ruins of an ancient church and round tower are enclosed within the old walls. There are also the remains of one of the finest Dominican Abbeys in Ireland close by the town. The abbey buildings are in a very bad state of repair, the owner of the land is unwilling to vest the buildings in the Board of Works, and some urgent repairs are being executed at the expense of a few members of the Royal Historical and Archæological Society. The date of the foundation is fixed at 1291. The founder was Gilbert, of the Clan Gibbon, ancestor of the branch of the Desmond family, afterwards ealled "The White Knights."

The title is now extinct, the last of the line being interred in this abbey. The origin of the title of White Knights goes back to the early part of the reign of Edward III., when that monarch was assisted against the Scots by a contingent of Irish troops, led by three cousins, members of the Desmond family. They were wounded, and greatly distinguished themselves at the Battle of Hallidon Hill, in which the Scots were routed. The three cousins were knighted on the field by Edward. One of them was in white armour, and he was called by the King, "Maurice, the White Knight." The other two wore green and black armour, and were designated the Black Knight and the Green Knight. The former was ancestor to the Knight of Glin, and the Green Knight was ancestor to the Knight of Kerry, the title of knighthood being in these instances perpetuated for five centuries and a half. In the centre of the choir in this abbey is the tomb of the White Knight. After we examined the abbey, old church, and round tower, not forgetting the police barrack attacked by the Fenians in 1866, we returned to our hotel to await the arrival of the train that was to convey us to Dublin on our return to the North.

We made a passing call on our way to the North at Drogheda, which is well worthy of a visit. We first examined St. Lawrence's Gate, and a portion of the Old Wall that still remains, and the ruins of the Abbey. We availed ourselves of an introduction we had to the Rev. Mother of the Sienna Convent, to see a curious relic that is preserved there. It is the head of Dr. Oliver Plunkett, Archbishop of Armagh and Primate of all Ireland, who was beheaded in 1681. It is in a wonderful state of preservation. It is enshrined in a little ebony casket, at each of the four angles of which is a Corinthian pillar of silver. There is a door in front in which is a silver plate bearing the Primate's Arms, surmounted by a silver mitre. On each angle of the roof is a silver flame, emblematic of martyrdom. When the door is open the head can be seen most distinctly through a glass plate. The Rev. Dr. Moran in his Memoir of Oliver Plunkett says—"Plunkett was doomed not only to

exile but to an ignominious death, which was in great measure precipitated by a few miscreants of his own religion and country, who raised for themselves everlasting execration and infamy."

We next proceeded to the graveyard of the Protestant Church of Saint Peter's. The Church was built in 1748, on the site of an older one partly destroyed during the siege by Cromwell. Many of the ancient monuments that were in the old Church are now placed around the wall in the Church-yard. Amongst these, there is a most peculiar monument, seven feet high, and has a representation of two skeleton figures, male and female; the date can be distinctly traced on the stone—"Obit Febri 16, 1516," is quite visible. The tradition about this monument is that the daughter of the Baron of Slane was drowned in the Boyne with her husband or lover, and when recovered the bodies presented the appearance of the sculptured figures. The words "daughter of the Baron of Slane" can be traced on the slab. It is said there is no Church-yard in Ireland where the remains of so many Bishops are interred; amongst them is Archbishop Ussher. The oldest of these tombs with partly decipherable letters bears date 1416. The family vault of the Moore's, Marquises of Drogheda, is enclosed by a very plain iron railing. The Magdalene tower is a prominent object when approaching Drogheda. This tower is a portion of the Dominican Abbey founded in 1224, by Lucas de Netterville, beneath which his remains are interred. The town teems with ruins of ancient religious houses. Saint Patrick himself visited this place, and a memorial stone, called Cloch Patrick, may still be seen on the Collon road with the carved impression of the Saint's knees upon it. Hugh de Lacy was Lord of Drogheda and Meath in the early part of the 13th century. There were two boroughs with different Mayors and Corporations; one on the Louth side, and the other on the Meath side. Continual jealousies and quarrels existed between these Corporations, which led to regular pitched battles on several occasions. By the intervention of the Primate a petition was signed in the year 1412, and for-

warded to King Henry the 4th, who by charter joined the two boroughs under one authority, after which there was peace. In 1394, Richard the 2nd visited Drogheda, when he received the submission of O'Neill and O'Donnell. Parliaments were frequently held in Drogheda, in 1444, 1453, 1467, 1495. In the wars of 1641, it was invested by 20,000 Irish under Sir Phelim O'Neill. In 1649, Oliver Cromwell attacked it with 10,000 of his troops and took it, putting over 2,000 men to the sword. In 1690, William the 3rd and James 2nd encamped within 2½ miles of Drogheda, where the battle of the Boyne was fought. It was the principal town of the English pale. From the most remote times the valley of the Boyne was the scene of some of the most stirring events in Irish history. There is no part of Ireland where there are so many ruins of Pagan and Christian times, and of ecclesiastical and military Buildings.

I was informed by an old lady who visited at the house of Balfour of Townley Hall near Drogheda, that the buff leather coat in which King William was wounded at the battle was in their possession ; that at the time of her visit some 50 years ago, it had been left in some attic or upper room, and it after wards was found that some of the servants had cut off portions of the skirt for cleaning the knives. This is a little bit of unrecorded history, and I give the story just as it was told to me. I made a call in Dundalk and informed a friend of my visit to the ancient Church-yard at Drogheda and the very old tombs that are in it. I was informed that tombs equally old and interesting are to be seen in the Church-yard of Saint Nicholas in Dundalk. In the chancel of the Church there is a very ancient stained glass window, with the following inscription in very antique letters :—

"Saint Andrew Faciolamus, Bishop, sprung from the noble family Corsini, a man universally esteemed for his boundless charity, and on account of his mildness the refuge of the people, the father of orphans, the spouse of widows, so he was all things to all people. Renowned by his miracles, having foretold the day of his death ; he died in the odour of sanctity, 1373."

There is an old tombstone with lettering in high relief; the following is a verbatim copy as far as I could decipher it:— "This monument was erected the fourth day of June, 1588, by the appointment and at the charge of (indistinct) Nugent for their buriall, unto whom God be mercifull." Another stone similarly carved reads—"Heere underlyeth the body of John Mortimer of Dundalk, Alderman, deceased the 8th day of May, Anno Domini 1534, unto whose soule the Lord have mercie, who had to wife Jeanette." The rest of the lettering is indistinct.

Another very interesting monument stands in Dundalk churchyard, on which is the following inscription, "Sacred to the memory of Agnes Burns, eldest sister of Robert Burns, who departed this life at Stephenstown, near Dundalk, on 17th October, 1834, aged 72 years. Her mortal remains lie interred in the south-east corner of this Church Yard as a tribute to the genius of Robert Burns, the national bard of Scotland, and in respect for the memory of his eldest sister Agnes, whose mortal remains are deposited in this Church Yard. Erected by the contributions of the poet's numerous admirers in Dundalk and its vicinity, 25th January, 1859."

"Time but the impression deeper makes,
As streams their channels deeper wear."

"She was, but words are wanting to express, what I think a good woman should be, and she was that."

The second portion of my paper refers to some explorations undertaken in the early part of June of the present year. Accompanied by three friends, we started from Belcoo, a village ten miles from Enniskillen, on the Sligo line. We visited the remains of a small Celtic church, of the 12th or 13th century date, called Temple Rushen, beside which is a holy well, still frequented during the last few days of July in each year. We next visited the ruins of another ancient church called Killinagh, beside which there is a holy well called Tober Bride. This

church is built beside a Pagan cemetery, near to which is a very peculiar stone containing nine basin-shaped cavities around a larger central basin. There is an oval or rounded stone, with evident marks of chiselling, placed in each cup. On the shore of the lake Mr. Plunket, of Enniskillen, who was one of the party, picked up a well-formed stone celt. We did not delay here, but proceeded to the left of the Sligo road, up a precipitous range of hills, which commanded a fine view of Lough MacNain and the distant hills of Sligo and Donegal.

Having visited this locality last year, I had obtained some information which led me to believe that there was a fine cashel here, the existence of which had not been recorded. After many inquiries, and procuring the assistance of a young man who lived in this locality, we at last found what we were in search of. In the townland of Moneygashel, on the farm of a man called Terence Coyle, who is a stonemason as well as a farmer, we found this ancient Cyclopean fortress. The internal diameter of the cashel is 85 feet by 83 feet, the wall is 16 feet thick, and stands at present to a height of about 8 feet. We obtained two photographs of it—one showing the ancient steps leading up to the top of the wall, and the other the portion of the wall that is best preserved. There are two pairs of steps within it, having one large step at the bottom from which a stone stair leads to the right, whilst another leads to the left. These are particularly interesting, as very few of our ancient cashels have the original stone stairs still *in situ*. The doorway has been partly restored by the owner, who, as I have stated before, is a mason, and has taken a great interest in the preservation of the fort. On the lowest ground within the cashel there is a small ope, only observable on the outside, about 12 inches high, and 18 inches wide. It was evidently the exit for the drainage of the interior. We examined a fine cromlech not heretofore described, detected in the distance by the keen eye of Mr. Plunkett, around which were observable other remains of a Pagan cemetery.

On our way to examine a rocking stone and two giants' graves

that are well known in the locality we stumbled almost over a building quite new to us. On inquiry we ascertained that it was a sweat house, and that it is still in use. Two weeks before our visit it had been used by four old women, who had taken a bath in it together. This primitive structure is situated in the townland of Legeelan, on the farm of a man called Hugh MacHugh. It is built of stone, beehive shaped, and measures 4 feet by 4 feet 6 inches inside, and 5 feet 6 inches high. The entrance is by a small doorway 2 feet high and 1 foot 9 inches wide. Those who enter have, consequently, to creep in on all fours. When the bath is going to be used (for a hot-air bath it is, the primitive type of our present Turkish baths, which would be more correctly designated Irish hot-air baths), the interior is heated by a large fire of turf being kindled inside and allowed to burn out. The ashes are then raked out and the floor swept clean. As soon as it is sufficiently cool to enter a green sod is placed inside for each person who enters either to sit or stand upon, and an attendant puts a sack or other covering across the door. Those who are inside soon commence to perspire, and no doubt this result is achieved quite as successfully as in our Turkish bath. After remaining inside from half an hour to an hour the patients, if we may call them so, usually take a plunge into a pool of water to cool, after which they rub well, and dress. We were astonished beyond measure at this revelation, as we ascertained that it was always used for rheumatic pains or to cure rheumatism in its various forms. On further inquiry we ascertained that there is another bathhouse of a similar kind in the townland of Toam, about two and a half miles distant, and that it is still used for the same purpose. Having made inquiries in various parts of Ulster since then, I have had further information. Within three miles of Maghera, County Derry, there is a fine example of a sweating-house of a much more ancient type than that already described. This County Derry example is built like the Rath caves, without mortar, and roofed across with flat flagstones, and it is oblong in shape. It measures inside from the entrance of the door 11 feet in extreme length, and 3 feet in

width. The doorway is 2 feet 3 inches high and 2 feet 6 inches broad. There is a hole in the top closed by a stone, removable at pleasure for ventilation. Outside is a pool of water, built around the sides with stones, and filled with water to a depth of 4 feet 6 inches. Near to this is a well of fine spring water. Here we have all the requirements of a Turkish bath. This may be seen in the townland of Tyr Kane, within three miles of Maghera, County Derry. It is not now in use, but is called "the sweat house," and its use is well known to the older people in the neighbourhood, whilst the younger people don't know much about it. In the County Tyrone these sweat houses have been used up to twenty years ago. I will conclude by giving a copy of a letter received from a gentleman in County Tyrone, which gives a good deal of information on the use of these primitive hot-air baths :—"Sweating-houses were common in this part of the country up to fifty years ago ; from that time up to twenty years ago they were wearing out of use. The last of them has not been used for twenty years, and even the ruins of it have now almost disappeared. Fifty years ago there was one in a glen about a quarter of a mile from where the Altmore Chapel now stands, to which the people came to get cured of pains for several miles around. It was built of a round shape, 7 feet wide in the clear, and 7 feet high, and covered over with large flags, except a very small opening on the top. Only stones were used in its construction, and the door was 4 feet high, and was closed by a flag for the purpose. In this case it was heated by fires of turf. When sufficiently hot the coals and ashes were removed, and some cool thing, such as sods, rushes, or stones, put in for the person or persons to stand upon. Then (when men) as many as six or eight stripped off and went in, when all openings were closed (except what afforded a little ventilation) by a person outside who attended to this matter. When they could suffer the heat no longer, the flag was removed, and they crept out and plunged into a pool of water within a yard or two of the sweating-house, where they washed, then got well dried, and put on their clothes. In the case of women, they generally kept on

a garment something in the line of a bathing-dress, then sweated, changed for a dry suit, and omitted the plunge bath. Of course people had to be careful not to lean against the walls inside, as they would get burned if they did. One, I remember, was cut or excavated out of a turf bank. It was only five feet high and five feet wide, of a round shape, and had a flagged floor. The opening was only three feet high, and was closed by a bundle of broom branches. It was heated by heather and dried grass and ferns, which were plentiful in the locality. The plunge pool was always used here. The constructor was a cooper. He once came home on crutches from a place (Beragh) he was working at from having lain in a damp bed. After four sweats he was quite well again, and continued so until his death, which took place fifteen years ago. This was the last one used in this part of the country. My father remembers when there were three or four of them in the immediate vicinity. Another was in a glen, where I have a plantation. A stream of water runs through the glen, and on either side are rocks. The rocks formed one half of the building, either shaped by nature or by excavation. The front was built up with stones. No mortar was ever used. It was partly covered by the rock itself and partly by flags, and was heated in the usual way—by burning heather and brambles in it. The stream was dammed up for the bath."

I will conclude by stating that the ancient Irish were well skilled in medicine and other curative remedies for the restoration of health and the cure of diseases. The chieftains had their own hereditary physicians, for whose maintenance they alloted large tracts of land, which were set apart as the exclusive property of the practitioners, and regarded as a sort of sacred territory in times of war as well as of peace. The independence which the physician was thus enabled to enjoy afforded him time to produce medical works, which were carefully transmitted from father to son, some of which have survived and come down to our time. There were special cures for some diseases in certain families. Many cures have come under my personal notice that I can vouch for. This hot air bath is one of the

remedial agencies that have been in use in Ireland from time immemorial, and the use of which has almost dropped out of sight. In this as in many other matters our ancestors had more knowledge and skill than we usually give them credit for.

Mr. Milligan then exhibited a carved oak Tudor panel, 5 feet by 3 feet. He said—This curious relic of the Tudor period, I think, must have belonged to Queen Elizabeth in the adornment of one of her palaces, as part of some piece of furniture, and not necessarily of a state bedstead, but may have been the back of a throne or state seat, or been placed over the fireplace. No subject, however great, would have dared to use the Royal insignia in his mansion as here carved, unless the sovereign parted with it to some favourite. Bequests of this kind are frequently met with in the will of some of our sovereigns. Elizabeth was particularly jealous of her rights in such matters. One of the chief reasons why Mary Queen of Scots lost her head was her assumption of the Royal Arms of England as successor to the throne, a caution to those who use unauthorised coats of arms. The Royal Arms of Elizabeth, with the Garter, is carved in the centre of the panel. It is ornamented with scroll work and other ornamentation peculiar to the Tudor period. The panel, when it came into my possession, was used as the bottom board of an ancient state oak bedstead, but, for the reasons stated above, it is likely it was not originally made for this purpose.

The paper was illustrated by original lantern views, exhibited by Mr. James Meneely.

Messrs. W. A. Ross, Thomas Workman, J.P., and Robert Young having criticised the papers, a vote of thanks was passed to Messrs. Milligan, Brown, and Vinycomb.

7th January, 1890.

JOHN H. GREENHILL, ESQ., in the Chair.

ROBERT PATTERSON, ESQ., and R. LLOYD PRAEGER, ESQ., B.E., Secretaries of the Ulster Fauna Committee, contributed a joint Paper on the

VERTEBRATE FAUNA OF ULSTER,

Which was read by the latter-named Gentleman.

THE Lecturer said :—By its geographical position Ireland is a country of much interest to the zoologist, since it is the extreme western extremity of the Continent of Europe, and often the first land at which American animals which have succeedcd in crossing the Atlantic arrive ; and it is, therefore, important to British zoologists that its Fauna should be thoroughly understood. This being the case, it is surprising how little attention the subject has received from naturalists ; and it may be of interest briefly to review the zoological work which has been done in Ireland, comparing the information we possess regarding its Vertebrate Fauna with that which is now obtainable relative to the Faunas of England and Scotland.

The books in which Irish zoology obtains any mention were then shortly dealt with, beginning with the oldest writers on the subject, and coming down through Giraldus Cambrensis, Walter Harris, Smith, Dubourdieu, M'Skimin, and Harvey, to William Thompson, whose book is still the standard work on Irish zoology. It was pointed out that in the space of more than thirty years which has elapsed since the publication of the last volume of Thompson's "Natural History of Ireland," no work has appeared containing anything like a complete account of the vertebrate zoology, either of the whole island or of any of the provinces, though the following local or partial

works will form most valuable contributions when this highly desirable undertaking is entered upon:—"The Guide to Belfast and the Adjacent Counties," by the Belfast Naturalists' Field Club (1877); "Guide to the County of Dublin," by various contributors (1878); "The Birds, Fishes, and Cetacea of Belfast Lough," by R. Lloyd Patterson (1880); "The Fowler in Ireland," by Sir Ralph Payne Gallwey (1882); and the "List of Irish Birds," by A. G. More (1884). The information respecting the Fauna of Ireland which the foregoing works yield was then compared with that which is to be found in the multitude of recent reliable works dealing with the vertebrate animals of England and Scotland, and upwards of a dozen books were mentioned giving full information respecting the birds, &c., of as many districts of Great Britain. The reader next quoted from some of the leading writers on modern British zoology, showing how they have drawn attention to the scanty information relative to Ireland, and have urged the necessity of further work in this department. One quotation, taken from "Essays on Sport and Natural History," by J. E. Harting, F.L.S., F.Z.S., the editor of the *Zoologist*, is particularly emphatic. He says, in conclusion—"We stand sadly in need of a good modern comprehensive work on the Fauna of Ireland, and one cannot doubt that the appearance of such a work would be hailed with satisfaction by the large and ever increasing body of British zoologists." It was then explained how it is proposed to supply this deficiency, as far at least as the province of Ulster is concerned. The Council of the Natural History and Philosophical Society, in response to a letter signed by Mr. Robert Patterson and the reader, calling attention to the great desirability of a modern work on local zoology, have appointed a special "Ulster Fauna" Committee, consisting of the President, Secretary, and Treasurer of the Society, together with Professor R. O. Cunningham and Messrs. R. Lloyd Patterson and Joseph Wright, with Messrs. Robert Patterson and R. Lloyd Praeger as Secretaries; the object of this Committee being the collection of authentic information respecting

local zoology, with a view to the compilation and publication of a reliable work on the subject. This can only be done by obtaining the assistance and support of all those who are interested in local natural history, or whose place of abode or occupations afford them opportunities for the study of the Fauna of their districts. A preliminary circular has been issued and widely distributed over the province, and already the Secretaries have received offers of assistance from many quarters; and the scheme has already been courteously noticed by the local Press. Mr. Praeger continued:—

Should our scheme meet with the support which we trust it shall find, and which we believe it merits, it is expected that in a few years' time sufficient authentic material may have been collected to warrant publication, and we shall then have a reliable treatise on the Vertebrate Fauna of Ulster, dealing with the birds, quadrupeds, fishes, bats, cetacea, reptiles, and amphibians of our province, with notes on their distribution, habits, and history, and treating especially of such points of Irish zoology as are still involved in obscurity. To bring this proposed work before the Society, and before the public, is the object of the present paper; and the Secretaries now appeal, not only to the members and their friends present, but to all whom they may reach through the medium of the Press, and to all who love science for its own sake and take an interest in the natural history of their native country, to assist them in this work, the successful accomplishment of which will, they believe, be for the advancement of science, the benefit of Irish zoology, and the honour of the Belfast Natural History and Philosophical Society.

The paper was spoken to in terms of cordial approval and endorsement of the objects and aims of the Ulster Fauna Committee by Professor Cunningham, Professor Letts, Robert Patterson, Esq., Rev. Canon Grainger and the President.

The lecture was illustrated by rare ornithological specimens, and a Mus Hibernicus, or Irish rat, which was pointed out as being extremely scarce.

Cecil Shaw, Esq., M.A., M.D., read a Paper on

MODERN PHOTOGRAPHY.

Dr. Shaw first dealt generally with the past of the Photographic art, and briefly laid down the chemical conditions which render photography possible. He explained the process by which the "dry plate" is produced, and the composition which is used in preparing it. He dealt chiefly with three requisites of photography, viz. :—Speed, quality of work produced, and portability of apparatus. Generally, he gave a detailed description of the manner in which an ordinary photograph is produced. Dr. Shaw then proceeded to describe some varieties and elaborations of the photographic process, beginning with negative making ; and proceeded to consider the printing of copies. Few people, he pointed out, know what marvels are now performed in the way of quick photography due to modern plates ; for, of the other two factors which determine the length of exposure, namely, the brightness of the light, and the form of the lens, one is unchanged, and the other not greatly altered. For instance, the flight of cannon balls and rifle bullets is now photographed, not as a curiosity, but as a scientific method of studying the art of war. He said he was indebted to Mr. Francis Meldon, of Dublin, for some splendid samples of instantaneous photography, and these were all the more interesting to a Belfast audience as the mechanism used to open and shut the lens was the invention of Mr. Thomas Caldwell, of Belfast. Having explained the nature of the instantaneous process and the requisite amount of exposure, he pointed out that with Mr. Caldwell's shutter any desired exposure can be given, from five seconds down to one-three-hundredth of a second. Photographs of the sun have, he believed, been taken in the one-thirty-thousandth of a second. He also explained and illustrated other forms of shutters for the camera. At this stage a number of illustrations were projected upon the screen, showing the results attained by different methods. The lecturer went on to deal with, and give specimens of, detective and isochromatic

work, and showed examples of the way in which combination printing is effected. He referred to the number of uses to which photography is now put, observing that it would be hard to mention any profession or business in which it is not at times useful. He pointed out that in the legal profession documents are being constantly photographed for use in court, and in at least one case in America criminals have been detected by camera. Photography is also valuable to the medical profession. He knew of at least two medical books in preparation in which micro-photographs would be largely employed as illustrations. The use of photography for military purposes was also referred to, as were its utility in the reproduction of pictures, even in the hands of exhibitors at the Royal Academy, and to the physicist, the archæologist, the geologist, the antiquarian, and the astronomer. He concluded in the words of the quaint old physician and philosopher of the seventeenth century—"The wisdom of God receives small honour from those vulgar heads that rudely stare about, and with a gross rusticity admire His works. Those magnify Him whose judicious inquiry into His acts and deliberate research into His creatures return the duty of a devout and learned admiration."

The lecture was spoken to by Mr. John Brown, Dr. Everett, Mr. W. Swanston, and the President.

16th January, 1890.

JOHN BROWN, ESQ., read a Paper on

THOUGHTS ON EDUCATION AND SCHOOLS,

Which, with the Discussion, is printed *in extenso* as Appendix I. to this Report.

4th February, 1890.

JOHN H. GREENHILL, ESQ., in the Chair.

DISCUSSION ON SANITATION.

PROFESSOR LETTS said :—I find it somewhat difficult to explain why I have been selected to strike the keynote, as it were, to the important business of the evening, inasmuch as I am not a practical sanitarian, and have never devoted myself particularly to the subject. Perhaps, indeed, it is my entire ignorance as regarded the practical aspect of the question which offers the only excuse for my being placed in this position. However, of the theoretical side of the subject I am of course, from the nature of my profession, obliged to know something, and upon this department I may be permitted to say a few words, though I may say at the outset I have no intention whatever of interfering with any of the practical details.

We may take it that the health of a community depends upon the supply of fresh air, good and abundant food, pure water, and facilities for the removal of excrementitious and

waste matter. Sanitation includes these four cardinal points. The death rate of any community is in proportion to the manner in which these four things are supplied. I propose to limit the discussion to matters connected with these four things. As regards food supply I do not think it is necessary for me to say much, neither am I competent to deal with the subject as an authority. Others, however, may desire to say something thereon, especially with reference to diseased meat. There certainly ought to be some guarantee that meat exposed for sale for human food should be in a perfectly healthy condition. Recently, as you are aware, there have been several cases in the local courts in connection with diseased meat, which have given rise to much discussion in the Press and elsewhere. This subject may, therefore, form one for discussion.

Next, the water supply is a very important subject indeed, especially when we consider the sources from which Belfast derives its supply of water. I believe I am right in saying that the whole of the supply is derived from upland surface drainage—what is familiarly known as surface water. This water, exposed as it is to many sources of contamination before being collected in the resorvoirs, is used by the inhaibtants of Belfast unfiltered for drinking purposes. I have always had rather a strong feeling with regard to the water supply of Belfast, and it seems to me there is a considerable degree of danger to health in the water drunk by the great majority of the population. Some time ago I had a controversy with Mr. Macassey, C.E., upon the subject. Several eminent chemists, including Dr. Wanklyn, and, I believe, Dr. Hodges, held that the supply was not good, and analyses were published to support the proposition. Dr. Wanklyn had a system of his own for comparing the purity of water. Dividing the organic matter into free ammonia and albuminoid ammonia, he submitted that water to be fit for drinking should not contain more than ·08 per million of free ammonia and ·10 per million of albuminoid ammonia. In the town supply, according to that standard, the water was pure enough as regards free ammonia, but not as

regards albuminoid ammonia, which it contained at the rate of ·15 per million. So that, as far as Wanklyn's test went, the town water should be condemned. I do not mean, however, to say that Wanklyn's system is absolutely reliable as a test of purity. The Cromac water is exactly the same as the town water, only it has filtered through the soil for 100 feet or so, and been very much purified thereby. The water used by most of the mineral water manufacturers is extraordinarily pure, especially that from Messrs. Corry & Co.'s well. The Cromac water sold by the carts, however, is far less good, probably on account of the well being contaminated by surface drainage. (Professor Letts here exhibited in decanters specimens of the ordinary water supplied by the town, the same when filtered and when distilled, and also Cromac water from Messrs. Corry's well.) Supposing the germ theory of disease to be perfectly accurate, as represented, then, if one person living in the upland districts from which the town supply comes had typhoid fever, he might be the means of infecting the whole town. Typhoid, as we know, has been rather rife in Belfast, and I have sometimes wondered whether it has any connection with this state of things. The only way in which the authorities can do anything to remedy what appears a very dangerous system, is by filtering the water through sand. That undoubtedly ought to be done. Mr. Hoskyns, a chemist, has told me he had found considerable quantities of phosphate in the town supply, which possibly had been dissolved from the manures used for fertilising the upland farms. It would be satisfactory to the public if periodical analyses of the water were obtained by the Water Board and published by them.

The next part of the subject upon which I will touch in passing is ventilation. The air of Belfast, I believe, is on the whole better than in most manufacturing districts. I have no data to corroborate that statement; it is simply my belief. At the same time, there are two sources of very bad air in the vicinity of the town. One is the Lagan and the other the Holywood foreshore. The latter is the most abominable stream

of bad air I have ever known, and living within its influence cannot be a good thing. I hear of cases again and again of persons living in Holywood who suffer continually from headache and other disagreeable complaints, which I attribute to the bad air. And until the foreshore is reclaimed the nuisance I fear will continue; there is no cure for it in any other way.

Dr. Letts then described different methods of domestic ventilation, and illustrated the principle of diffusion by several interesting experiments. Referring to the porosity of bricks (which he also illustrated by a very ingenious experiment), he said there is no doubt that ventilation occurs partly in this way, though not to a very great extent. It has been suggested to him that there is a source of danger in it, assuming the microbe theory of disease, because the wind would blow the microbe, against the bricks, and the latter, not being sufficiently porous to let them through freely, would become absolutely saturated with them. Dicussion on the whole subject of ventilation would, he thought, be highly interesting.

The last subject to which I will refer is that of sewerage. That is a subject I approach with great diffidence, because so much has been done during the last few years with regard thereto that it seems presumptuous for anyone but a practical sanitarian to attempt to deal with it. Nevertheless, it is one of the most important of the matters which is to be included in our discussion. Sewers as at present devised are arranged to carry off three things—first, the excrement of men and animals; secondly, water; and, thirdly, the street mud and waste from factories. These matters, being already in a state of putrefaction on entering the sewer, or speedily afterwards becoming so, soon generate gases. These gases are principally nitrogen, sulphuretted hydrogen, carbonic acid, marsh gas, and volatile organic matter. None of these gases in very small quantities are extremely dangerous, but to breathe them in larger quantities is very generally admitted to be extremely prejudicial to health. But there is a curious contradiction between recent theory on this subject and experience. It has

been shown that microbes pass off in excrementitious matter, so that we should naturally expect to find them in the sewers, and, as a matter of fact, we do so find them. But persons who have investigated the subject have found that the sewer gas, at any rate, is freer from the spores of these microbes than the ordinary air. There are methods by which not only the spores can be detected, but their numbers measured ;—by applying this ingenious test the fact I have referred to was discovered, and it is proved beyond doubt that the air of the sewer is freer from microbe spores than the ordinary air outside. I cannot reconcile this statement with the undoubted fact that sewer gas causes disease. I will leave it to the audience to do that. At present we are right in placing some reliance upon theories, but very much more upon experience, and I will say that, whether it may contain few microbes or many, and although we do not know in what way it acts to produce disease, we are quite justified in endeavouring to keep sewer gas out of our houses. (Dr. Letts then exhibited a number of glass models of appliances for trapping drains, &c., and performed a number of experiments illustrating their action.)

The CHAIRMAN then called upon

DR. CALWELL, who spoke on the relations of micro-organisms to disease. He said :—The microbe theory has revolutionised our ideas of disease altogether. It is known that a large amount of disease is avoidable, especially diseases which are caused by micro-organisms. First of all, we have the class of disease which is caused by micro-organisms, and in that is included tuberculosis. Consumption, blood poisoning, and some diseases which occur among cattle and sheep, as Pasteur has discovered, belong to it. It has been proved that the dust on the walls and floor of a room inhabited by a person who has died of consumption is able to cause tubercular disease in animals. The second class of disease to which I will refer is typhoid, scarlatina, and certain forms of inflammation of the lungs. It seems probable that in time we shall demonstrate that these diseases are caused by micro-organisms although this has not yet been

shown scientifically. The third class of disease embraces those of which micro-organisms are not given as the exciting cause, such as cancer and certain forms of rheumatism. What I may term dirty damp is the cause of the latter disease. It is seldom or never caused by clean damps, such as exposure to dry cold or to snow. The question may be asked how these micro-organisms cause disease, as they are so minute, and their presence cannot explain their effects. Intoxication, or in its worse form *delirium tremens*, is the effect of the persistent use of alcohol, and may be called the disease of the yeast plant. The plant, however, does not grow in the blood; it is outside the body. Last year a medical man in Leicester examined the micro-organisms that arose from the ground in autumn and subsequently in winter, and in the other seasons of the year. He found that in autumn, when English cholera and other like diseases were extremely rampant, the microbes were exuberant of growth, and of different character from those found in the other seasons. This will explain the disease that may arise from the foreshore of Holywood, and that which follows from house to house where the buildings are erected on cast material. Microbes, a great many of them, are extremely tenacious of life. To destroy them we require strong chemicals or excessive heat—heat which a human being is unable to bear. Another method is the dilution of the poison. Dispensary doctors suffer more from typhus fever than those engaged in fever hospitals, as they have to invade unsanitary homes, while the others work in well ventilated rooms.

Mr. L. L. Macassey said:—In the course of a couple of years Professor Letts, the Belfast public, and myself will be one way of thinking, as the water of the city, both high and low levels, will be filtered. The Water Commissioners, before proceeding for their last Bill, sent a deputation to examine a number of the most lately-constructed filters in the kingdom. I, however, believe that even unfiltered the Belfast water is a fairly wholesome water. Professor Tidy held that opinion and said it was suitable for its purpose, although he believed

filtration would improve it, and I agree with him. The Commissioners have now made up their minds to carry out the filtration works in the most modern style, and give to their constituents a water supply second to none in the three kingdoms. It may be asked why did they not do so some time ago. The reason was that they were short of water, and they tried to overtake the requirements of the town before setting about the work of filtration. They have now plenty of works and plenty of water, and the work of filtration will soon be in active operation. If it had been done some years ago the Commissioners would have been obliged to raise the rates, which, it is hoped, will now be avoided. Professor Wanklyn showed that with the ordinary sand filter in use by the London Water Companies something like 90 per cent. of the microorganisms are destroyed by filtration. I have had large experience of water works in many places, and I know that even with filtration the consumers may be using impure water. In a great many small houses open cisterns are used. In fact, in miles of streets in Belfast they may be seen, and it is impossible under these circumstances to have pure water, no matter how filtered. The germs of disease are blown into these cisterns, and it is no wonder when it finds a footing that it spreads over the whole district. It rests with the owners of property to see that their tenants get the water in its purest condition so far as cisterns are concerned. I also hold the opinion that sewage matter should be got rid of by water carriage, as according to the best authorities this carries away the microbes. It is of more importance to have a system of water sewerage made perfect than that we should derive profit from the sewage matter. It is better to pay a good price and get rid of it than make a little money at the risk of life and health. The main drainage of Belfast will be of great benefit to the inhabitants, and when this is completed, and the filtration works in progress, I believe the death-rate will decrease very considerably.

Mr. Richard Patterson took exception to the statement of Professor Letts regarding the Holywood foreshore and its effects.

He said :—In my capacity as Chairman of the Town Commissioners of Holywood I can inform the Professor that the men engaged in removing the seaweed enjoy better health when working at it than at any other time. The Press casts a kind of slur on Holywood generally, but if we look at its death-rate we shall find it in the first rank. In fact, it can turn out more old people than any other place I know of. The inhabitants there live to an extraordinary age. The registration of Plumbers is not only a great benefit to the trade, but a great safety to the general public. We have now a branch of that organisation in Belfast, of which our worthy Mayor is Chairman, and myself Vice-Chairman.

Mr. Patterson then proceeded to show the most improved method of ventilating rooms, and the most modern application of the Plumber's skill, in which he exhibited all the newest sanitary arrangements.

Mr. J. C. Bretland (City Surveyor) said :—The difficulties connected with engineering in Belfast are of no ordinary character. In Bristol, Nottingham, and other cities in England they have good gradients, but here we have good and bad gradients. We have a vast flat over which a large portion of Belfast extends, which is only above tide level, and much of which is filled in ground. A reflux tide acting on this brings a sort of soakage or a permeation of the water under our very feet. I only wish I could lift that flat ten feet above the tide, but, as we cannot raise the level of the town, we have tried to lower the level of the sewers. This is an important matter, and when the low level drainage is completed I believe the sanitary condition of the town will be very much improved. The Corporation may, however, construct sewerage works and make outlets, but unless the minor details of which we have been hearing are attended to honestly, the sanitary condition of the city will not be much advanced. The two should go hand in hand, and if they do so, I believe much good will result.

Mr. Conway Scott said :—I do not think the Belfast water is as bad as represented. I should be sorry anyone would take

a drink of Cromac surface water instead. Mr. Corry's spring is right enough, but the surface water that is sold as Cromac is not good for drinking purposes. As to open cisterns in small houses, I can assure Mr. Macassey that the working classes draw their supplies from the mains and not from cisterns, and that the water they use is better as a rule than that used in larger houses. The better class people on application to the Commissioners can enjoy the same privilege. With regard to dispensary doctors dying of typhus fever, I think it a mistake to die of this disease. I and the other sanitary officers are in as many houses of the kind as the doctors, and probably more, and yet we never catch the disease, simply because we take the necessary precautions. Sanitation I regard merely as the prompt removal of filth. Ventilation is the removal of filth or vitiated air from a room. I hold, as trees and plants are purifiers, that every town should have as many open spaces as possible. All we can do is to remove the filth of our atmosphere up to a higher level, and allow nature to do the rest. I recommend the ordinary domestic sanitary arrangements to be placed outside the dwelling-house, and the filth to be removed daily from the houses of the working classes.

Mr. S. F. Milligan gave some useful hints as to the arrangement of windows for the purposes of ventilation. He also stated that people should be very careful about going into houses built on cast material, or on soil that has not been drained.

Mr. J. Brown referred to the introduction of the electric light into dwelling-houses as having a beneficial sanitary effect. He complained of the ventilation of some of the public buildings in Belfast.

Mr. John Lanyon dealt with the ventilation of sewers. He suggested the destruction of impure gases by furnaces or the lamps on the streets.

Mr. Maxton having spoken,

Mr. Wm. Gray moved the adjournment of the debate, which was agreed to, the Society to give notice of the next meeting.

4th March, 1890.

John H. Greenhill, Esq., in the Chair.

Professor Fitzgerald, C.E., read a Paper on

THE THEORY OF THE SCREW PROPELLER,

Which is printed as Appendix II. to this Report.

The Chairman having put a number of questions to Professor Fitzgerald arising out of the paper, called upon

Mr. John H. MacIlwaine, who said that, in his opinion, the Professor has launched a completely novel theory on the subject of the Screw Propeller, namely, that the vortexes in which the screws work should have screws made to suit them. He considered that there is much difficulty as to the question of pitch being ascertained mathematically, and gave three reasons why he believed Professor Fitzgerald's theory is not practicable.

Mr. J. Maxton did not consider that the theory put forward would be of any practical result, as, in his opinion, the Professor's ideas are not in accordance with those which would result in the construction of a perfect Propeller.

Mr. Walter H. Wilson gave some interesting results regarding the lapping of twin Propellers, as observed in a model made with screws fifteen inches in diameter. The after Propeller was found to go slightly faster than the other, say two revolutions in the minute. This was found to be the case with regard to the steamer Teutonic.

Professor Everett having offered a few remarks as to twin screws,

Professor Fitzgerald replied.

Robert Young, Esq., C.E., read a Paper on

SOME NOTES ON THE UPPER BOULDER CLAY NEAR BELFAST.

Mr. Young prefaced his paper by referring to his paper of last session describing the sections at the Greencastle Water Reservoir, where the remains of a yew tree forest in the boulder clay was exposed. Above this there is a thin bed of vegetable matter, which is succeeded by a covering of upper boulder clay. This locality is 200 feet over sea level. Since then, he stated, he has found at Ligoniel what he believes is another patch of the boulder clay referred to, in which a portion of a small yew tree was also discovered. The interesting point is that at this place there is no lower boulder clay or intervening vegetable bed, but the upper clay rests directly on the surface of the *keuper* marl beds. The paper was illustrated by diagrams, and by various objects found in the excavations.

Mr. William Gray, M.R.I.A., offered some criticisms.

H. Pearce, Esq., read

NOTES ON A COLLECTION OF BUTTERFLIES.

Of the sixty-six varieties of Butterflies contained in the collection, forty are to be found in Ireland. Mr. Pearce gave a description of the different varieties of Butterflies which he presented to the Museum. The paper was illustrated by diagrams and limelight views.

The Rev. John Bristow, in criticising the paper, stated that he had found last summer, at Ballycastle, several specimens of the moth *Nyssia zonaria*, which was thought to be exclusively confined to the district of the Mersey, in England. He mentioned that he has in his collection a specimen of the Camberwell Beauty (*V. Antiopé*), which was taken on a wall near Parkmount, Belfast.

1st April, 1890.

John H. Greenhill, Esq., in the Chair.

James Maxton, Esq., read a Paper on a

PROPOSED SUBMERGED BRIDGE BETWEEN IRELAND AND SCOTLAND,

Which, with the Discussion, is printed as Appendix III. to this Report.

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APPENDIX 1.

THOUGHTS ON EDUCATION AND SCHOOLS.

BY J. BROWN.

Here and there in the works of John Ruskin we find a favourite teaching of the great master which tells us that the foundation of good writing and speaking, as well as the highest possibility of intelligent, profitable, and enjoyable reading is found in a familiarity with the original meaning and derivation of words.

It is largely educative in itself to try to trace words from their primitive purity through changes by which they have descended to their present meanings. Changes which have perhaps left them sullied and almost ostracised from polite lips, though they started pure and innocent at first.

We are familiar with such examples as villain, knave, etc.

The word education is, I think, also in danger of falling from its high estate, and it may not be a profitless task to endeavour to think of its original meaning when, with the new-born enthusiasm of the first recognition of the thing itself, the coiner of the word chose the materials out of which he forged it *E*—out of, and *duco*—I lead.

In scheme I. I have tried to give a diagrammatic sketch of what I take to be the true meaning, and in II. a view of its antithesis, too commonly received as the accepted meaning at present.

I.

EDUCATION.

(Leading out of)

PUPIL.——Love, trust.——TEACHER.

Will to follow. Capable to lead.

(*Freedom*). (*Sympathetic*).

∞ Activity.

∞ Natural Responsibility.

∞ Impressions.
(Permanent). } Ideal Man.

II.

ANTITHESIS.

(Cramming, Repression.)

PUPIL.——Distrust, fear.——TEACHER.

Unwilling. Force.

(*Captive*). (*Birch*). (*Master*).

0 Activity.

0 Responsibility.

0 Impressions.
(Evanescent). } Paralytic Idiot.

In comparing the two, we see that scheme I. implies something already in the pupil to be brought out, *i.e.* improved so as to be of value. The teacher must have the power of leading or bringing out this,—a power coupled with sympathy—and relying on and encouraging the pupil's will to follow, implying freedom on his part, and a consequent relation of trust between the two.

This freedom of the pupil fructifies in a healthy activity, a wealth of activities, signified in the extreme limit supposed to

be indicated in the diagram as ∞ (infinite) activity. The feeling that he trusts, and is trusted, fructifies in wealth of natural individual responsibility for his own actions ; and the teacher's power of sympathetic leading conveys to him wealth of impressions (knowledge and skill) of a permanent character. It will probably be admitted that an education implying the practice of ∞ activity, the habit of ∞ natural responsibility, and the acquirement of ∞ permanent good impressions, would produce a near approach to Ideal Man.

In scheme II. we have the antithesis of all this. The pupil is regarded as a mere void to be filled, his attitude mere unwilling, inactive receptiveness=0 (zero) activity. The teacher is a mere master, full of force, but without sympathy, and consequently ignorant of his pupil's needs, and so unable to convey assimilable good impressions to him ; or those he does manage to produce are a mere varnish of apparent goodness, without any real education of good principles or sentiment below it. He produces 0 permanent good impressions. In his excellent little work, *Theory and Practice of Teaching*, the efforts of such would-be teachers are quaintly satirized by Edward Thring, once Head Master of the famous Uppingham School, and, in some ways, one of the truest of practical educators, and to whose work and life I shall have frequent occasion to refer.

"It is," he says "useless pumping on a kettle with the lid on. Pump, pump, pump. The pump-handle goes vigorously—the water pours—a virtuous glow of righteous satisfaction and sweat beams on the countenance of the pumper, but—the kettle remains empty."

The distrust necessarily accompanying such a relation engenders a habitual suspicion which destroys all manly feeling of natural responsiblity on the pupil's part, and we have 0 natural responsibility. A product possessing no habit of activity, no responsibility, and no permanent impressions is evidently not far from a Paralytic Idiot.

The two diagrams represent the extremes of opposite methods. It is not meant that any present system of so-called education produces paralytic idiots any more than that any possible system

could produce ideal men. It is only meant that in so far as the treatment of children follows one or the other scheme, in so far will it tend towards producing ideal men or paralytic idiots. Unhappily, because it is generally more presently easy to spoil than to make, there is a tendency to helpless sinking towards the spurious method :—a tendency abetted in the home by ignorance of what true education means, and in the schools by the various State invented and State controlled systems of school management which rely on methods, and ignore men, and chill with the "dead hand, the pitiless hand of ignorant power" that which should be warmed and vivified by the living heart.

The foregoing seems to present itself as a broad and general view from which we may proceed to more detailed particulars.

We have proposed as the aim of true education—the formation of ideal men and women.

Thring in his *Theory and Practise of Teaching* says "Power, or efficient life, is proposed as the aim of every educator ;" and he proceeds in a very beautiful way to define true life. He defines education as that process which best produces power in man himself, and makes him capable of employing his faculties in the best way. Not be it observed power over his fellow-man, which Thring very forcibly likens to the slave driver's whip, at every stroke of whose lash the real creature, as distinct from the working machine, hides itself, and the love and hate which is in the man himself, and which, whenever he does man's true work, passes into that work, retires farther and farther into the depths of the cavernous heart out of sight. Not this power, but power in man's self for true work.

Similarly the founders of the Prussian National System defined education as "The harmonious and equable evolution of the human powers :" implying probably a harmony of evolution where an equable culture applied to all the human powers would educe in their true largeness of individual growth those whose embryo strength was naturally great, while not neglecting the culture, as far as possible, of those which were naturally deficient.

From a somewhat more egotistical standpoint Herbert Spencer defines education as 1st, a preparation for direct self-preservation; 2nd, indirect self-preservation; 3rd, for parenthood; 4th, for citizenship; and 5th, for the miscellaneous refinements of life. Spencer considers that these divisions subordinate one another in the order given, because the corresponding divisions of life make one another possible in that order. His definition leans perhaps, too much to the egotistic or self-seeking side, and neglects as did the older economists, Adam Smith for instance, the altruistic, or other seeking, side of our nature which is at least of equal importance.

James Mill defines the end of education to be "to render the individual as much as possible an instrument of happiness, first to himself, and then to other beings;" a sufficiently wide and perhaps rather indefinite view.

In an address entitled *A Liberal Education* we find Huxley, in that clear, beautiful English peculiar to himself, comparing life to a game of chess—"The chessboard is the world, the pieces are phenomena of the universe, the rules of the game are what we call the laws of Nature. The player on the other side is hidden from us. We know that his play is always fair, just, and patient. But also we know to our cost that he never overlooks a mistake, or makes the smallest allowance for ignorance. To the man who plays well the highest stakes are paid with that sort of overflowing generosity with which the strong shows delight in strength. And one who plays ill is checkmated—without haste, but without remorse. . . . . . Well, what I mean by Education is learning the rules of this mighty game. In other words education is the instruction of the intellect in the laws of Nature, under which name I include not merely things and their forces, but men and their ways; and the fashioning of the affections and of the will into an earnest and loving desire to move in harmony with those laws."

This also savours a little of egotism, and we have, I think, a more nearly perfect definition by Wordsworth, when he says: "And here I must direct your attention to a fundamental mistake by which this age, so distinguished for its marvellous

progress in art and science, is unhappily characterized—a mistake—manifested in the use of the word education, which is habitually confounded with tuition or school instruction ; this is indeed a very important part of education, but when it is taken for the whole, we are deceived and betrayed. Education, according to the derivation of the word, and in the only use in which it is strictly justifiable, comprehends all the processes and influences, come from whence they may, that conduce to the best development of the bodily powers, and of the moral, intellectual, and spiritual faculties, which the position of the individual admits of."

From one point of view—a somewhat physiological standpoint—life consists of the absorption and evolution of energy—we eat and breathe to live — we live to act. The body absorbs food and air, and evolves work. The mind absorbs knowledge, and evolves thought ; but when we have learned that this is so, we have not learned to live ; and the point that I now want to emphasize, and to thoroughly bring out, is that it is only by the actual *practice* of these absorptions and evolutions in the best way that we learn how to live ; that what our children need for the education or cultivation of their faculties is first, *Wealth of Activities* in themselves, coupled with *Wealth of Impressions*, and so far as possible, *Individual Responslbility* for results. And the atmosphere in which these activities, impressions, and responsibilities flourish is emphatically Liberty to the utmost possible.

What then are the qualities and faculties to be cultivated ? The more important may be grouped as follows :—

PERSONAL QUALITIES.

1.—Bodily health, Strength, Dexterity.

2.—Judgment, including accuracy, observation, and discrimination ; Reasoning Power, Industry, Resource, Patience, Hope, Courage, Endurance, Originality, Self-respect.

3.—Curiosity, Memory.

SOCIAL QUALITIES.

1.—Honesty (or honour).

2.—Sympathy (considerateness, charity).

3.—Gratitude, Veneration.

The maintainence of bodily health is from one point of view not strictly a part of education at all, since it implies not a leading out of anything in the body, but rather a prevention of the entrance of disease into it. Without health, however, education, of course, cannot progress, and its very importance, while emphasising the need of a study of hygiene by the parent and trainer, places its discussion beyond the circumscribed limit of space and time at our disposal. The cultivation of sufficient muscular strength and dexterity will follow automatically the giving of free play to that amount of activity which nature demands, and which cannot be without harm refused.

As Spencer says:—"It was the opinion of Pestalozzi, and one which has ever since his day been gaining ground, that education of some kind should begin from the cradle." In a paper of this kind, it would, of course, be impossible to do more than touch on a few points in so wide a subject, nor do I feel competent to do more than refer to one or two aspects which have more especially come under my observation. Rules can, indeed, at best be only of the broadest, for in true education there must be a facility for the freest intelligent treatment of each individual case according to its needs from day to day. Not only is every child different from every other, but the same child never exists two days running; we have a partly new one every day, and it is the trainer's watchful care to catch and preserve the good as it appears in the flux and change of the growing life, while letting the evil pass discouraged away. The neglect to recognise these universal and everchanging differences is one reason why the educational codes or school systems with their machine-like details are so inefficient. Machines turn out splendid pins or postage stamps all of the same materials, beautifully uniform, and for few and circumscribed uses; but the machine has yet to be invented which will, at one operation, produce from granite paving-stones, and from marble the Venus de Medici.

In the very early treatment of children, I think what strikes the male mind most distinctly is the amount of assurance with which any and every female undertakes the difficult and arduous

task of bringing up children. How many of us here to-night would undertake to produce a gooseberry bush, or grow a parsnip, or cultivate a bed of asparagus properly? Yet, advertise for a nurse, and any ignoramus that cannot make a bed or cook a soufflè thinks herself, and is often thought, good enough. It is a significent fact that a nurse's wages are less than a cook's. A spoiled dinner or an uncomfortable bed appeal immediately to the senses, but the hope of a life passes, by the conventional, presently easy system, uncared for away.

One result of this policy of assurance is a meddling and interfering with Nature's ordinary laws of growth and health—bad ventilation, especially at night, too little exercise, improper food, and too much restriction and repression generally. Wordsworth says: "To the solid ground of Nature trusts the mind that builds for aye." Surely the natural wishes and feelings of the child are a guide for its physical treatment worth at least as much attention as the old wives' fables that hang about the nursery.

Were it not indeed for sympathy, ignorance might tell a sadder tale. Sympathy often teaches how to lead as well as why to follow; for though following, that is obedience, must be learnt early, it is the obedience of love, not that of fear. The need of punishment to enforce obedience is, I think, nearly always the outcome of bad training at first. It would be out of place here to discuss the data or standards of ethics; the important point is that the motives to right conduct of the child, and its rules and sanctions should be as far as possible exactly the same as the motives, rules, and sanctions of the man. The child's first need is a power in himself of judgment as to the rightness or wrongness of things; his next is the ability to follow the guide of his own judgment manfully and well. The fear of parental anger or the rod as a consequence of certain acts stigmatised by parental authority, but nohow else, as "bad," or the expectation of parental payments in the shape of bribes of various kinds for "good" deeds, are therefore evidently excluded from right training, being mere makeshifts for the convenience of the parent or teacher of a purely temporary character. They

supersede the child's individual power of judging between right and wrong, and therefore retard its development. For the child morality is defined as "what I say"—sometimes a sufficiently confusing definition—and one in which the child grows unnaturally, as in a metaphorical glass-house, of parental authority, every pane of which reflects the imperial parent's image, and gives only a blurred view of the real world. All very well till a pane breaks; then the child has to begin afresh to educate himself after walking out of his conservatory, and finding that outside in the fresh air it is qualities like truth, judgment, self-reliance, hope, love, and courage that are wanted instead of the petty deceit, fear, and helplessness so suitable within. The system of authority is a system of repression, not of free growth. Every check to a child's free action, every "Don't!" seems to me like a rough touch, sending the feelers of his intellect shrinking back only to repeat the same distressful tale—"We have failed again."

May we not fear one of two results? Either the capabilities, losing hope and courage, will die and vanish, or reacting against the too vexing chain, seize excess of that liberty of which their natural share was denied, and with neither love nor respect to restrain, develop a miserable disregard for all wishes outside themselves. One might almost add as an axiom—Never say "Don't" to a child—well, hardly ever. Clear away his original ignorance first by pointing out the right path. Tell him in a fair, frank, friendly, confidential way what he is expected to do, then do not hurry him; a little quiet time at first for the unpractised little mind to grasp the new view, and helped on by respect and affection for his teacher, he does the right because he sees it is right. It will hardly be questioned that the moral effect here far supersedes that of mere unreasoning obedience to continual stern and uncompromising commands; and self-reliance and repose of manner are best cultivated in a quiet environment where the child has time to grow and ripen naturally without friction and consequent needless loss of nerve force. If, as sometimes may happen in the earlier stages, a command must be given, its kindly unrelentingness will gather force from

its extraordinariness. Parental authority should, therefore, be sparingly used, like the salt put in sweet dishes—just enough to bring out the flavour—or as the onion in a salad, which, as Sidney Smith tells us should only

> "* * * * lurk within the bowl
> And, half suspected, animate the whole."

More spoils all, and in the limit, we have our pie all salt, our salad all onion, and our method like that of the Irishwoman who, as the story goes, says to her little girl—"Run, Bridget, darlin', an' see what yer brother Patrick is doin', and fwhatever it is, tell him to sthap at wanst!"

This kind of treatment seems often to arise from an assumption that children are born bad; with a natural tendency to evil, and that continually, unless either forced or cajoled into an uncertain and quite temporary and merely apparent or skin-deep morality, so far as that term is nnderstood by the parent. A good deal of what is often anathematized as original sin may be simply original ignorance. It is difficult to imagine a wrong which would be committed if the perpetrator could fully realize the whole of its evil results, but his original ignorance prevents him. Clear away this completely, and that "best he can," which he will do in any case according to his lights, increases as his light grows—his evil tendency vanishing conversely.

In consequence of this frequent adoption of the opposite view children are commonly supposed to lie naturally. *A priori* one would not think so because truth is the simpler and obvious course. To invent lying requires a strong incentive, such as fear, and a certain amount of design and reasoning power, in which young children are deficient. But they may be taught deceit by example, under the foolish though common error that they have not the wit to distinguish truth from falsehood, and so it is forgotten that an example of truest, purest honour must be set children by taking care that not the faintest falsity of dealing with them is ever permitted. Of the methods which involve an example of deceit may be mentioned the trying to cure a child's little troubles by directing his atten

tion to something else, or pretending that it was not his fault that his head was bumped by the "naughty chair" or the "bad table that hit him." Let him rather face his difficulties like a man and help him to conquer of his own strength; he will learn to take better care also to avoid accidents in future. Equally reprehensible is the inveigling him into doing what we want or going where we wish, by a pretence that he and we, dear friends, are going to do something quite different. I knew a child of three once who said "No" to almost everything, from pure fear of being inveigled, gathered from the sad experience of even his small life. What must be the state of that mind to which, by our acts, we say: I cheat you; but I hope you will be honest; and I expect you to put great faith in me; I wheedle and bribe you in the interests of manliness; I rule you by fear in the name of love? Yet it was said by one who was called beloved "perfect love casteth out fear," and surely fear cannot dwell with perfect love.

A child should be treated with respect. It is manifestly absurd to hope that he should have self-respect if he be constantly treated disrespectfully; moreover, if no disrespect be shown to him it will not occur to him to treat others disrespectfully. He has consideration for others because no other plan has been shown him. A common infraction of this rule is the making of personal remarks about children. Why should they be subjected to a rudeness which we should not dare to indulge in with older persons? Another is the forcing of children to make advances to people they shrink from. A child politely treated will be naturally polite to anyone, but it is as injudicious to try to force him further as it is absurd to expect him to like everyone he meets. Another is the "showing off" of the child as a pretty automatic toy, which can recite poetry, play some simple air, or answer a difficult question. The fond parents are amused, and their friends pretend to be: for the child the result is a cultivation of vanity, self-conceit, and a false idea that what he has done is admirable for its own sake, whereas he will later waken to the sad fact that the applause was a tribute of politeness exacted by his parents. A child is too holy a thing to be made a fool of in this way.

Still another infraction of the rule of respectfulness is the bathing of children in the sea against their wills. There seems to be in this an utter want of sympathy with the child's natural dread of water, a dread which one would imagine sufficiently obvious in his heart-rending cries. I have known a yacht-owner say he could never bring himself to try to learn swimming, because of the horror of water born of his early bathing experience.

Ridicule has no place in the training of children, and bribery by rewards of such things as they value, or of eatables, is simply immoral, and the last is gluttonous besides. It is just a question also how much evil is put into children's heads by the elaborate and fussy precautions sometimes taken for its prevention, and the implication that though naughty it is nice. Nothing that is naughty can be nice ultimately, and whatever is ultimately nice cannot be naughty, whatever theory of morals we adopt. It is perhaps thought I overrate these things, and that contact with the world afterwards will soon cure such small ills. Well, I do not think they are small, and why should there be all the trouble of kicking out by the world what should never have existed if we had performed our part truly and well.

May we not rather recognise children as more probably possible angels than certain fiends? As little friends—still ignorant but intensely capable of learning—individual human entities to be respected as such, and who will return that respect to us; whose capabilities and moralities grow by actual active practice, not passive reception of authoritative precept—who are, to use a botanical parallel, endogenous not exogenous.

This implies that a child's future is, to an extent much greater than is usually supposed, a direct and certain product of his environment from the first moment of his life onwards. A pure, new-formed human mind is more impressionable than wax. Every action, every movement, perhaps every thought of those around it, every effort of its own leaves a ripple on its unsoiled and mobile surface; an undying mark which, congealing as the child grows, moulds for ever the

character of the man. The twig whose curve the future tree will so faithfully reproduce follows each breath of influence, good or evil, as truly, as helplessly as the gossamer is helpless in the summer wind. Keeping this in view, it is evident that everything that is done for or to the child, from its birth onwards, and most especially all things done by him, his play, his work, his modes of thought, his impressions and activities of all kinds should be examined and considered before everything purely as factors of the future man. With this golden rule constantly in mind from the first, an intelligent parent would need few further hints as to details, and would easily and naturally keep clear of the few pitfalls I have spoken of, besides many of the others that lie all along the path of early training.

I have said children are intensely capable of learning. A healthy, bright, well-treated child, in a world all so new to him, is intensely anxious to learn. He is in a state of continual curiosity; his natural appetite for information is difficult to satisfy. Shall we deny him and say "O don't bother me, children should be seen and not heard," and send him shrinking back from our hard, cold exterior, and so blunt his habit of enquiry and dull his appetite for knowledge, an appetite which we shall afterwards endeavour to revive at the point of the schoolmaster's cane, or by the cajolery of rewards and punishments, having no direct rational connexion with the object in view?

I think a child's every question should be answered faithfully and truly, no matter whether he understands the answer or not—he understands more than one imagines. But even if not, our answer is good for two other reasons: It shows our friendliness and establishes love, and his effort to understand is a mental gymnastic not to be despised.

The utility of object lessons as introduced by Pestalozzi has been much and deservedly lauded. Their difficulty lies first in choosing suitable objects, and then in arousing the child's attention to and interest in them. Both these difficulties vanish when nature prompts the child himself to choose the next object and implants the needed interest, and thus the teacher's work is more than half accomplished.

After the desire for information has in this natural way been encouraged and fostered, and the child has obtained sufficient store of knowledge to work upon, he may be helped to think out the answers to his own questions, and when this has been practised, and the child's mind begins to rejoice in its strength, working material may have to be supplied in the shape of problems for solution. The delighted enthusiasm with which even very young children wield a "scientific imagination," and plunge into the mysteries of cause and effect, is but the younger brother of the motive that led Newton to the secrets of the planetary system and sent Columbus across the wide Atlantic.

Children ought to be allowed to see everything possible, not merely for amusement, but for the educational value of wealth of impressions, also to do everything possible for the sake of wealth of activities. The child's first request for a pocket-knife, hammer and nails, or other simple tool, is Nature's hint that dexterity is now anxious to evolve itself. We disregard it only at the risk of losing much healthy growth of this quality. Children ought also, as far as possible, to be allowed to take the natural consequences of their own acts, of course under supervision sufficient to prevent dangerous results, in order to evolve through the teachings of actual experience that ability to adapt means to ultimate ends, the increase of which, as pointed out by Spencer in his *Data of Ethics* is a concomitant of the passage from lower to higher orders of life. Never mind dirtied clothes or cut fingers, or even the chance of a broken bone or two. Children's bones are less liable to breakage than those of the awkward adults that repressed children grow into, and the wash-tub should be subordinate to the activities that lead them into fresh embraces with mother earth.

It will, perhaps, be thought all this involves great trouble. Nothing worth having is obtained without trouble. The trouble of their production is a measure of the worth of most things. The Germans conquered France, it is said, simply by taking infinite trouble beforehand; and it is this

trouble beforehand, this effort to overcome the inertia of starting properly at first, that is more than half the battle in education. But it repays itself at more than compound interest afterwards in smoothing the future way of training, and in pleasantness of intercourse with a properly started child, as compared with one whose training must be a serious business in trying to fit it on an imperfectly-formed nucleus.

Of course the art of training is not equally easy to all. We are all born children, but only some are "born parents." To some of us it is an art acquired only with difficulty and carried out as an arduous duty, while to others there are few things more interesting than to watch and help the growth of a child's mind, to feed it as it needs new thoughts, and to feel that every new act is a new bond of sympathy between oneself and him; to mark the quaint way in which our old, dried, familiar ideas are dressed up in his new, fresh view of them. We grow young once more by sympathy, and we feel the added charm of hope for a bright and happy future for him who has given us this power.

The love, respect, and trust of the child is the threefold cord by which he may be led. We cannot buy love for favours any more than we can compel respect or trust by force. True love is given for true love, and we shall be respected as we are respectable, and trusted as we are true.

Omitting for want of time many points in early training, we pass on now to the period of School Life, which should be a continuous process with that just indicated, and on the same main lines, viz: Wealth of Impressions, Wealth of Activities (especially this because the powers are now stronger and more capable of active service), and Natural Responsibility. It will, however, be perhaps convenient to point out first some of the defects of the modern systems, which mostly seem to begin by making the assumption that mere knowledge is education. It is not difficult to trace the cause of this assumption. It was

no doubt found at an early period that one great factor in the process of imparting education was the imparting of knowledge to the pupil. It was only a factor, and it no more formed the total of education than the supply of an elaborate set of musical instruments produces sweet music.

"Of education," says Butler, "information is the least part." But the masses saw that the educated man, the man who had in himself power over matter and mind was necessarily a man of knowledge, and they put the cart before the horse, and said "knowledge is power," and the *Ich kenne*—I know—of the Germans seemed no doubt almost synonymous with the *Ich kann*—I am able.

Knowledge guides power. If knowledge itself were power, then one of the most powerful things on earth would be the *Encyclopædia Britannica*, seeing it is full of knowledge. It is not the first time in the annals of humanity that the idolatry of the tree of knowledge has led to a fall, and to dire need for a tree of life.

Solomon said: "Of all thy getting, get"—not knowledge—"get understanding." Solomon was a true educator. Thring says:—"The idolatry of knowledge must cease or education cannot begin." The authors of our modern school system, however, having set up the old traditional knowledge idol, naturally proceed to cram in information regardless often of either its suitability or permanence. They remind me of a travelling tinker that did a job for my mother once: "Will that stick now?" said she. "Yes, ma'm, it'll stick till I get out of the gate, anyway." The *tinker* was honest.

Thring says: "If school work means the spending year after year in making up little packets of knowledge of every boy, and packing them tight like portmanteaus, jumping on the lid when things won't fit in at last, nothing more need be said. There is no immortality in a grocer's paper bag or a knowledge packer." "Mere knowledge is not power, and mere knowledge is not education."

It is sometimes claimed for the mere knowledge system as an educator, that it is supposed to cultivate memory.

It is perhaps a question whether it does or not ; but again we hear from Thring—"A great memory is a great maker of common-place, unless overmatched by much original power, and the attempt to load the mind with knowledge often means crowding out all originality and freshness, and putting very little in."

It is to be admitted, however, that the acquirement of knowledge by the pupil, in a legitimate and natural way, is a necessary factor in education. The definition of education by Spencer also demands more directly the acquirement of a considerable amount of knowledge for its own sake—of a kind, moreover, not usually taught in the schools at all—such as that in preparation for parenthood and citizenship. The old method was, of course, to hammer it in with a stick, after having previously (also, of course) neglected entirely the cultivation of the child's curiosity or natural desire for information. As Spencer puts it : "We drag the child away from the facts in which it is interested, and which it is actively assimilating of itself. We put before it facts far too complex for it to understand, and therefore, distasteful to it. Finding that it will not voluntarily acquire these facts we thrust them into its mind by force of threats and punishment. By thus denying the knowledge it craves, and cramming it with knowledge it cannot digest we produce a morbid state of its faculties, and a consequent disgust for knowledge in general."

Corporal punishment was too often, on the part of the teacher, a mere revenge for trouble given, and so utterly bad for both teacher and pupil. As an old song says—

"If the mind would'nt mark,
Then, faith, he'd mark the back,
And he gave them his own
With the devil's own whack."

In the pupil it cannot fail to produce a deadening of all elasticity and original mind power, and a brutalizing of himself and his companions who are witnesses. Thring, however, thought flogging a necessity in a great school ; it was at the same time to be under the most carefully-made restrictions, and only to be

administered by the head master or his deputy after due consideration. The question of corporal punishment is a difficult one, because school systems are in a transition state. In matters of conduct, possibly when boys have been utterly badly trained at home, it would require a master of much higher power than those commonly met with to deal with them ; but the kind of man safe to trust with the rod is scarcely less high. Possibly the difficulty with such exceptional boys whose presence in a school, as Bain says,* "is a discord and an anomaly," could be got over by the means he suggests "in removing them to some place where the lower natures are grouped together."

Respecting the rod as a spur to learning, it is difficult to see why children in Britain and slaves in other countries should be the only portions of humanity whose work is extracted by the rod. Would the subjection of other workers to the same rule be tolerated ? Would a factory manager be sustained in flogging his half-timers if they neglected duty ? Is the schoolboy of so much less value than a mill doffer ?†

In America corporal punishment is no longer in vogue. Mr. William Workman, kindly permits me to quote the following information on this point obtained last year by the kindness of a friend through Professor Moore of Illinois, who has been for twenty-five years connected with public schools in that country and who writes :—

"The most important change which has been brought about with these later years, has been the coming in of more sympathetic relations between teacher and pupil—in less show of authority, and more real power ; in letting down the formal barriers of restraint, and letting in a sweeter and truer control ; in bringing the teacher's platform nearer the pupil's desk, and

* *Education as a Science*, p. 116.

† In an article entitled "The Education of Children" in *Macmillan* for January last, I find :—"Idleness is generally a sign either that the work is too difficult, or that it is unsuited to the child . . . . When children are dull it is the business of the persons who are educating them to find out why they are dull, and apply the right remedy." This is exactly my view, and I recommend the exeeedingly well-written paper containing it to those interested in children. My attention was called to it since the reading of my own paper.

the teacher closer to the pupil's mind and heart ; in furnishing a mellower light and purer air for the school-room, the teacher has kept pace fully with the architect. This is why we need not corporal punishment."

"The State law of New Jersey explicitly forbids the infliction of corporal punishment."

"The following cities have abolished corporal punishment in their schools:—Brooklyn, N.Y.; Philadelphia, Pa.; Washington, D.C..; Baltimore, Md.; Chicago, Ill.; St. Louis, Mo.; Cincinnati, Ohio, and smaller cities have followed their example."

E. A. Schellentrager, President, School Board, Cleveland, Ohio, says:—"One of the most important steps taken by the Board of Education—a step taken, as I believe, in good faith, and in the interest of humanity—has been the permanent abolishment of corporal punishment. It is a matter of special pleasure to inform you that the discipline of the classes has not suffered through the abolishment of corporal punishment."

Extract from Report of New York School Board.—"The bye-law prohibiting corporal punishment of any kind is an essential part of the system of discipline. It has diminished the number of suspensions, and has added a pure tone to the school."

In this country the system is now more or less obsolete, and in so far, is supplanted by a system of bribing the pupil to assimilate knowledge himself. We try the cajolery plan: we have prizes and competitions: we assume that the pupil has no appetite or desire to learn and must be stimulated. As I have said before, I believe this to be a fallacy. A properly trained child is eager to learn if not overpressed—even to master the drudgeries of the three R's, and if properly taught, learns well and thoroughly. How is it that our preparatory schools are freest from prizes, examinations, and result fees? Ruskin and Thring agree that "all you can depend on in a boy as significant of the power likely to issue in good fruit is his will to work for the work's sake, not his desire to surpass his fellows." *

* Edward Thring as Teacher. p. 22.

To come to our own city, we have our good friend, Mr. James O'Neill, a gentleman professionally engaged in preparing students for examination and the gaining of distinctions by the display of their acquired knowledge. We have Mr. O'Neill telling us that one of the most prominent desires of the youths and maidens of this city is a desire for knowledge, and he proceeds to compass the gratification of that desire by the Extension of University Education Scheme, of which he was the prime mover.

It will be remembered, perhaps, that in the *Nineteenth Century* for November, 1888, there appeared a protest against the Competitive Examination and Prize System. It has been signed by 857 prominent men and women: 15 are members of the House of Lords; 94 members of the House of Commons; 406 teachers, professors, and persons connected with education; 62 medical men; 280 in other walks of life. Besides these, 56 signed with some reservations.

Mr. Auberon Herbert, who was the originator of the protest, has published a collection of the letters received by him from all sorts and conditions of people in reference to it. The book is entitled, *The Sacrifice of Education to Examination*, and contains over 200 communications, of which about one-tenth appears to be in favour of the present system. The opinions expressed classify themselves under seven divisions which I propose to state, and give one or two of the more important remarks made under each head.

Against the competitive examination system the indictment is generally that it is fallacious and unnecessary, that it means disaster to all true education and true teaching, and the substitution for true education of a mock worship of *formulæ* and the dry husks of things. As carried out by the State it is a mere factory system, with a necessity for an unnatural and utterly objectionable uniformity of product and centralization of power. Both these are death to true education; individuality suffers; originality is destroyed. It is to be remembered that the indictment as regards examinations is against *external* examinations only, that is, those not conducted by the teacher himself of his own pupils for teaching purposes.

1. FALLACY OF EXAMINATIONS AS A TEST.

The indictment against examinations as a test is that they are not a test of education in the true sense at all. They usually test memory only, but are not a sure test even for that.

PROFESSOR BLACKIE.—"The qualities which make a young man capable of performing effectively the duties of any public station, are not in any wise identical with those which enable him to make a good appearance in a school examination."

MICHAEL FOSTER, M.A., F.R.S., &c.—"Again and again I have known men whom I have been obliged to speak of as good examination men who did not prove of great value in after life. Again and again I have known men who have not done well in the examination room who have been of enormous value in after years."

2. PRIZES AND COMPETITION ARE UNNECESSARY.

MR. E. C. PRICE, a teacher, says :—"A good teacher will get better results without the artificial stimulus of marks and prizes." "The lame teacher wants a crutch, don't have a lame teacher."

When in Canada last spring I had a long conversation with Mr. Marling, the Chief of the Education Department at Toronto, and one of the things he mentioned was that the giving of prizes was discouraged by the Department, though local authorities might if they liked provide them at their own expense. In the Girls' Normal School, Philadelphia, where the pupils numbered 575, the chief, Dr. Fetter, told me they could not think of offering prizes. There was some competition for a place in the examination for a diploma at leaving, which he said was often too strong an inducement towards overwork ; in the ordinary work of the school there were no prizes whatever. Mr. MacAlister, Superintendent of Public Schools in Philadelphia, said he was entirely opposed to the prize system, and that it was unheard of as an important adjunct to schools in Philadelphia. The answer of a bright lad who showed me over that splendid institution, the Manual Training School of Philadelphia, was characteristic. When I asked if they gave any prizes there, he replied, with an amused smile, "No, sir ; I guess we came here intending to work." What strikes one

in these American schools, as compared with British, is the life and interest of the pupils themselves.

3. THE EXAMINATION AND PRIZE SYSTEM DESTROYS TRUE EDUCATION.

PROFESSOR R. B. CLIFTON, M.A., F.R.S., Fellow of Merton and Wadham, Oxford.—"I fully believe that competitive examinations carried to their present extent obscure the true meaning of education, destroy the best teaching, degrade and retard the advance of the subjects studied."

JOHN RUSKIN in *Fors Clavigera.*—"Farther, of schools in all places and for all ages the healthy working will depend on the total exclusion of the stimulus of competition in any form or disguise."

The PRINCIPAL of a Girls' College.—"They (the girl pupils) are usually successful in the examinations, but in culture are far, far behind the pupils of twenty years ago, who read and digested the best authors."

E. F. V. KNOX, All Souls', Oxford.—"I gained a good deal in pocket by the Irish Intermediate Examination, but at the expense of my education."

AUBERON HERBERT.—"We all know that it is easy to get striking effects from stimulants of all kinds, but we also know that their effect is specially for the moment, and opposed to the normal processes of health." And again, referring to the degradation of the study of English Literature: "As things are, it can only be hoped that some subjects which are most fitted to develop delicate perceptive powers will not be taught. To teach English literature in view of a great competitive examination is to run the grave risk of destroying the charm which many minds, at a later period, might find in it. A subject full of suggestion of delicate half-lights and shadows can only be coarsened by such treatment, and the bloom rubbed off from the bud before it has opened. You might as profitably have a competitive examination in religious feelings."

M. E. BUDDEN, M.A., Grammar School, Bury.—"The evil, as regards mathematics, is obvious. Men are carefully trained

in working problems, and dare not spend any time in really *studying* mathematics. Very few English Mathematicians reach the first rank for this very reason."

4. DESTRUCTION OF ORIGINALITY AND INDIVIDUALITY.

PROFESSOR MAPOTHER, M.D., Examiner in the Irish College of Surgeons.—"An all important final competition chokes out the power for original thought and original work, by which alone our Science is to widen its boundaries."

REV. E. K. BLUMHARDT.—"My idea of education is to teach children to think for themselves; this end is to a great extent defeated by the present system."

REV. T. TRAVERS SHERLOCK.—"Enthusiasm and originality cannot flourish."

SIR F. LEIGHTON, Bart., President, R.A.—"I hate everything *machine-made*—probably a machine-made education is amongst the worst products of that order of operation, and I believe that the evils you speak of, the premature sterilizing of the intellect, the mischievious overstraining of the frame, the misdirection of the energies, &c., &c., do frequently, probably very frequently, accompany the systems prevalent in our day, and that the flower of individuality must needs suffer in this numbing atmosphere; but of all these things I *know* nothing of my own knowledge and experience. I got little of my education in England, and never in my life competed for anything."

AUBERON HERBERT.—"Sterilising uniformity, loss of personal choice and of self-direction, and consequently, loss of interest are such fatal injuries, that it is in vain we turn on a river of gold to fertilise our favourite schemes."

E. K. CHAMBERS, M.D.—"This cultivation of the memory is injurious to the powers of observation and reasoning. They become atrophied from want of use."

I have noted over forty more opinions similar to these.

5. EVIL OF SUBSTITUTING A MERE LOVE OF PRIZE-GAINING FOR TRUE DESIRE FOR KNOWLEDGE.

Sir T. H. FARRER, Bart.—"I deprecate with all my heart the

substitution of a desire to gain prizes for real love of knowledge. It degrades learning, and prevents the prize earner from appreciating it."

S. Dill, M.A. (Late Head Master, Manchester Grammar School, now Professor of Greek in Queen's College, Belfast).—"It is quite true, as the late Rector of Lincoln long since pointed out, that the concentration of the powers on the winning of prizes always weakens, and often destroys disinterested love of knowledge."

It is a question how much of the large development of trashy reading matter now produced is a result of our school systems. It is an old maxim that play is a parody on work. So our school-work being all intense reading, the product must read for amusement (he can't think), and we have the penny dreadfuls and shilling shockers, and a multiplication of comic papers, so called, and our brains are addled and kept from thinking with *Tit-Bits*, *Rare-Bits*, *Scraps*, *Answers—et hoc genus omne*—soul-destroying vapours from the modern hurry of life. We have also as a result of that system that bloodless and fleshless thing the modern Text-book in numbers and repulsiveness which it is no wonder Thring compares to the frogs in Egypt—"Manuals, rules, and technical terms," he says, "Technical terms, rules, and manuals possess the land, and bear potent witness to the theory of the Pump."

6. DETERIORATION OF HEALTH AND TRUE LIFE BY INDUCED OVER-PRESSURE OF WORK.

The system is morally bad because untrue. We want the pupil to acquire knowledge. What we tell him we want is: that he shall pass certain examinations. We place a false issue before him, and he accepts it to his detriment and the destruction of true life. The resultant physical evil is well known—body and brain are deteriorated, the children become natives of Kingsley's Isle of Tomtoddies—all heads and no bodies, and with only turnips heads after all, and watery ones at that.

Rev. Dr. E. Warre, Head Master, Eton.—"It is the able and the studious boy who in the main suffers. Many a bright, keen intellect of 10 or 12 has become dull and blunt, and has

lost its temper by 15 or 16, owing to over-preparation with a view to scholarships. In such cases the mental elasticity gets what the engineers call "a permanent set," and rarely recovers itself."

Writing of over-pressure among girls causing illness, Dr. J. H. AVELING says:—"My advice is always fresh air exercise and no mental strain. If this is adopted, the patient gradually improves; if it is not, she developes into a highly nervous and morbidly emotional woman, giving birth, in case of marriage, to a weak and deteriorated offspring."

R. W. MACDONALD, M.D., in a long letter on the evils of over-pressure says:—"Many and many are the lives of innocent and helpless children thus sacrificed to the folly, stupidity, and ignorance of parents, school-boards, and teachers."

"The moment a child begins to rave about its lessons in its sleep it is time to stop."

D'ARCY THOMPSON in his charming little book—*Daydreams*—when speaking of girls' schools as they are, says:—"The Chinaman squeezes the feet of his women into lumps of helplessness, but the more ingenious European transfers the pressure to the female brain." And again, of schools as they should be: "I would never forget that I was training children, not to be schoolmistresses, but gentle ladies in a drawing-room, and gentler mothers in a nursery."

Rev. DAVID MACRAE in *Americans at Home*, describing a school in Lower Canada, says:—"Too little beds stood side by side upon the floor in front. I asked Sister Gaudry what these were for. 'These,' she said, 'are for any of the children that might fall asleep during the exercises.'"

7. EVIL OF PAYMENT BY RESULTS.

Against payment by results, besides an intensification of all the evils heretofore mentioned under the head of the competitive system, there is the additional indictment that the schoolmaster becomes a mere commercial speculator—a head of a factory, paid on piece-work to turn out copies to a certain pattern, beyond which he has neither time to go nor interest to take him.

As Professor Patrick Geddes, of Dundee University (to whom I am indebted for many valuable thoughts), puts it, he is a baby-farmer. It is well if some of the babies do not succumb under his process.

The whole tenor of Matthew Arnold's *Reports on Elementary Schools* for the years succeeding the establishment of payment by results in 1863 is adverse to that system. So soon as 1869 he says :—"The school examinations in view of payment by results are, as I have said, a game of mechanical contrivance, in which the teachers will and must more and more learn how to beat us. It is found possible, by ingenious preparation to get children through the Revised Code examination in reading, writing, and ciphering, without their really knowing how to read, write, and cipher."

Even Mr. Mundella begins to doubt the efficiency of the "dead hand." I find in the *Northern Whig* of November 30th last—"Mr. Mundella, speaking at the prize distribution at the Stalybridge Mechanics' Institution to-night, said 'that he believed in England too much attention had been devoted to machinery and too little to men. In the future we should have to rely upon our men and improved education.'"

In the Canadian Education Department payment by results was, I was told, tried some years ago and given up. The schools are supported half by government, half by local rate. The grant depends partly on the salary of the teachers, who are appointed by local trustees, and partly on the number of pupils attending. The teaching in the schools is kept from possible laxity by periodical visits of an inspector, who must have given evidence of teaching power before appointment to this post.

In the Philadelphia schools when I enquired about payment by results, I was asked what that was, and the smile of amused pity that followed my explanation was instructive. Here also there were inspections from head-quarters, but, as I gathered, more to examine *the teacher* and his methods at any time the inspector happened to call, and to give advice and assistance, than to hold examinations of the pupils at appointed times, for which they might be prepared. If there must be inspection

this plan is at all events preferable to the external examination system where, as Thring puts it,—"Teaching is not possible if an inspector is coming to count the number of bricks made to order. . . . . The inspector destroys teaching because he examines by pattern, and the perfection of teaching is that it does not work by pattern. . . . . Minds cannot be inspected, minds cannot be produced as specimens on a board with a pin stuck through them like beetles." An intelligent public can be its own school inspector. It would have better encouragement to become so in these countries if authority did not assume that it is a public too incapable, and its school teachers too dishonest, to be trusted alone together.

The Duke of Argyll :—"Payment by results sounds unassailably excellent, until we remember that everything must depend on the kind of "results" which are secured. So far as primary education is concerned, I fear that evidence is accumulating to the effect that the "results" arising are—(1) an overburdened memory, (2) a weakened brain, (3) an early withdrawal from all discipline of education,—an early withdrawal from school altogether."

Principal J. V. Jones, M.A., University College of South Wales :—"In the examination of Intermediate Schools in Ireland there is a system of direct payment on the individual pass, as in the Science and Art examinations. This is pernicious in connexion with intermediate education, and ought to be swept away. The evidence is that it exercises a bad effect on the Irish schools."

Sir Sydney Waterlow, Bart.:—"The system of payment by results has, I believe, been most injurious as a whole to the young men and young girls who have been educated in our middle and upper class schools during the last twenty years. . . . . As chairman of the board of governors of a large school in Westminster (800 day boys and 200 boarders), I have for more than fifteen years, taken the greatest interest in its management and progress. I can testify to the general improvement in the education of all the boys since the head master was prevented from competing for result money."

I have noted eighteen other similar quotations besides several dealing with the evil effect of payment by results on the teachers morally and physically.

JOHN RUSSELL, Editor of *The Schoolmaster*, says:—"Payment by results is the curse of the country."

I quite agree with him. I have had some personal experience of it in a school in the management of which I at one time took a part, and it would be difficult, I think, to devise a scheme which (as applied to the poorer classes for whom it was no doubt primarily devised) more ingeniously defeats its own ends. The teacher, hurrying for his annual crop of "results," has no time to wait for the slow brain of the untutored mechanic—*He* may go home. It is his richer brother who had been able to pay for early training in the past, and who has leisure for study in the present, that brings in results.

Of the opinions in favour of the present system in Mr. Herbert's book, some are from notable people, but the only argument which seems worth a reply is the plea that the examination system has worked a transformation in the industry of the Universities which we can hardly realize. This is admitted, but it has done its work and, as Herbert explains, instruments are not to be confounded with moving causes. The moving cause was the *Zeitgeist*—the spirit of the age—and examination the instrument it employed. Our instruments of progress are always changing. "Brown Bess," so covered with glory in the past, will not do for our troops to-day. Indeed the very circumstance of fitness in the past should have warned the cautious man against fitness in the future.

What, then, is to be our modern "Brown Bess"? What is to be our ideal school? This is a difficult question, and one that has puzzled wise heads before now. It is easier to see faults than devise a new perfection. One may, at all events, freely suggest improvements in the hope that criticism and discussion may lead to better things. For very young children, especially those whose home-life is not as bright as it might be, I think the best known training is to be found under the Kindergarten system. And

it need not be further referred to—being already established and appreciated—only it should be in the hands of really trained Kindergarten teachers who understand its object, and are naturally capable of carrying it out.

For older children another question may be disposed of here at the outset,—whether boarding or day schools are best. Circumstances sometimes decide definitely in favour of the former, but where there is a possibility of home boarding I am strongly of opinion that it is safest and best, unless the home is a very sorry affair indeed. One of the chief reasons for sending a boy to school is of course that he may rub against his fellows and get rid of awkwardness and the shyness bred of a solitary life at home, and learn *savoir faire* and *savoir vivre.*

In fact in the great English public schools the boys to a large extent educate each other. In the older days this seems to have been all the real education they got there. But there is something terribly wrong in the system which makes it necessary that in order to be educated young children should have to go through the tortures and misery described in *Tom Brown's School Days* for instance. There would appear to be little reason why this mutual education cannot be equally well obtained in a good day school, and if not quite perfectly, the deficiency is more than balanced by the risk, which I have good reason to think is great, of bad influences and acquirement of bad habits. The breaking up of home influences for good and sweet lives is also not to be lightly thought of.

A difficulty which hampers us a little at the outset is the need of making provision for preparation in some cases for a University career. For unfortunately our Universities, so far as regards their teaching or professional methods, work largely by the competitive examination and prize system. The large number of subjects, and the nature of the subjects, and the way in which they must be "got up" to pass some of these examinations do not accord, I think, with the best ideas of culture or advancement of learning.

If the mere honour and dignity of a degree be all that is wanted, or the "pecuniary value of a first class" be the object,

then the University career fulfils its end, but if real work be contemplated I am rather of Huxley's opinion that the advancement of knowledge is not the object of Fellows of Colleges: that "in the philosophic calm and meditative stillness of their greenswarded courts, philosophy does not thrive and meditation bears few fruits." The men who keep alive the old tradition of our intellectual eminence "are not trained in the courts of the temple of science, but storm the walls of that edifice in all sorts of irregular ways, and with much loss of time and power in order to obtain their legitimate positions. Our Universities not only do not encourage such men, ... but as far as possible university training shuts out of the minds of those among them, who are subjected to it, the prospect that there is anything in the world for which they are specially fitted." We must, however, do the best we can and hope for a reform of the university system,—perhaps in the direction indicated in the pamphlet issued by the authors of the University extension movement, wherein the statement that "their method treats examinations only as a means for assisting the effectiveness of teaching" looks like a condemnation of the system with which they are most familiar.

The object of the school cannot be better stated than in the words which describe that of the Manual Training School of Philadelphia, in some ways perhaps the nearest approach to an ideal school which has come within my observation. "The object of the school is the education of all the faculties. The whole boy is put to school. He is trained mentally, physically, ethically, and is fitted to enter upon his life work without loss of time, and without error in the choice of occupation." Included in this is the axiom that in a good school the pupils should learn how to learn. This is broadly our object.

As to the method. As I have said before, we must work by love and trust, and cast out fear and suspicion. The greatest need is sympathy between master and boys. This is the touchstone by which all designs, all acts, all proposals must stand or fall. As Thring says:—"The teacher must be full of human sympathy, inwardly exhaustless in kindness and patience;" and

again, "The last point that will never be neglected in a great school . . . the necessity of trusting the boys, and allowing them liberty to do anything that a wise father would wish his son to do." I do not of course mean a blind and lazy trust such as that apparently referred to and so properly anathematised in the chapter on "School-boy Honour" in Dr. Hime's *Home Education.* Where there is the proper sympathy between teachers and boys the former will feel instinctively where anything is wrong, and such mal-practices as Dr. Hime describes will be impossible. Such sympathy is not by any means incompatible with a feeling on the boys' part that the teachers are quite able for any black sheep among them if need should arise ; a feeling that requires with the average boy to be strengthened by swiftness of resource in circumventing by clever and unexpected means any wrong-doing on the part of the more ignorant. An incident from Rawnsley's little book *Edward Thring as Teacher and Poet* illustrates this. "He often, as boys phrase it, "scored so." Thus on the occasion of a school row the whole school had been gated, and up the Big School walked the Head-master with a look of triumph, and serve-you-fellows-well-right upon his face. A slight hiss—a thing unheard of before—escaped the lips of some few of the imprisoned malcontents. Thring stopped, faced round defiantly, and said—'That's right ; there are only two animals on earth that make that noise, the viper and the goose ; hiss away!' The boys were hard hit, and the whole of Big School broke into a loud cheer."

Are we likely to find men of this stamp among those who spend their youth pot-hunting for scholarships and prizes ; who regard learning as a beast of burden on which they may ride to place and power, and who are compelled so low as to make a study of the petty failings and idiosyncracies of individual examiners, so as to wriggle to success through some of their foibles ?

Yet boys, like other ignorant or half-formed people, can only be *led* where there is this true power of mind and quickness of resource, and the tone of secure strength in him who possesses it. From these they cannot withhold allegiance, and they admire

true power of this kind, I think, even more than their elders, and their fresh young minds can perhaps judge the capability to use such power even without its actual exhibition, and their admiration readily lays a foundation for that friendship, and the getting the boys on the side of the masters on which Thring lays so much emphasis. For this purpose the masters should join in the boys' games, and meet them outside the school-room and clear of its formalities. "It is most refreshing," he says, "to emerge from a slaughter-house of concords, moods and tenses, strewed with murdered participles of language, into the open air; most refreshing instead of looking on boys as reservoirs of bad grammar and vexation, to escape to a thorough good game and restore the balance of human nature by a hearty sense on both sides of both understanding a good drive or cut," and so on. It goes without saying that no master can command either respect or sympathy whose moral character is not also of the highest. Whatever a few black sheep may think the mass of the school will respect a true man. The teachers should also be men whose hearts have not grown cold with age, men who are still within hail of the age of their pupils, and above all, men who have the ability to teach.

Unless in the rare cases where this high teaching power is combined with great learning, in a way too excellent to be common, it is perhaps better that the teacher should not be too far advanced beyond the pupil in knowledge of his subject, since unless they have intense sympathy, men of great learning are prone to forget the tyro's difficulties, and so fail to make matters clear from omitting some point unknown to the pupil, but for which with them familiarity may have bred contempt.

True education progresses by contact of mind with mind, therefore let the tone of the school be the very highest attainable, especially let the teachers be true men unsullied by any meaner objects. Let them be like what Socrates defined himself as,—A man midwife for mind, who assisted other people to bring into the world new births of mind. Socrates who, as Thring puts it, taught nothing, and would himself have been plucked in a modern competitive examination, yet produced disciples who learned everything.

The capabilities of a true teacher are born with him—and they are rarely born. The true teacher must be searched for as for hidden treasure. It is useless to fish for him with the examination net. He is of far too fine and spiritual a nature to be caught in its gross meshes. We must try some other means of capture. The true teacher feels as it were with one hand the mind of his pupil, the other is on the subject he is communicating. The lecturer grasps with both his subject. The grinder of "results" has one hand on the examiner's mind, the other in the pocket of the State.

It is an absolute need that there be a sufficient number of masters. Thring gives twenty-five boys as the limit for one master to attend to. Beyond this lecturing takes the place of teaching.

Next to the human influence is the influence of inanimate things. The school and its surroundings should be beautiful. The idea is as old as Horace,—"Soak the new jar in sweetness then long years will not exhaust the perfume that it bears." The school arrangements should be all towards the convenience and natural happiness of the pupils. Good work and good growth are incompatible with discomfort and misery in any form. Making boys unhappy without cause may ruin them, cannot make men of them. You might as well, as Canon Farrar expresses it, "throw a piece of Brussels lace into the fire with the intention of changing it into open iron work."

The qualities to be educed in our school have already been enumerated in groups, beginning with Bodily health, Strength, Dexterity. Considering how great is the admiration for personal beauty and strength, as compared with the similar mental qualities, it is somewhat remarkable that the first attention is not given in schools to the cultivation of the highest bodily health which is doubtless the ultimate producer of both.

Mr. James MacAlister in his address on *Physical Training in Education* says truly—"A school should not be a hot-bed for forcing mind by artificial processes. It should be a garden in which the child grows into the healthful exercise of all its

powers under the genial influences which nature so clearly indicates. . . . And it may be taken as an absolute fact that the best intellectual culture is only possible when mind and body are alike regarded, and are trained to work harmoniously in one . . . . Even the supreme end of all education, the training of moral power in man, the ability to seek the right and to do the right depends to some extent upon the healthy action of the bodily powers."

On these lines the Americans have been wakening up to the need of gymnasia for their students, and some of their institutions of this kind with their thousand and one appliances for every conceivable exercise indicate the energy with which our cousins go ahead with such things, once they are convinced of their fitness.

Besides mere gymnastics, exhilarating games perfect the muscular development, train hand and eye, and promote health and good humour, and are therefore to have every encouragement. Boating, on account of the exercise it affords and the self-reliance and resource which it (especially sea-boating) encourages, is an excellent means of training, as is also riding for similar reasons. A certain amount of light manual labour, such as gardening to which many boys take kindly, would be healthful, and would have a good moral effect as well.

Proper food, and pure air by night as well as by day, are matters of which the necessity is more freely acknowledged than the practice adopted. The human organism has been fitted to live in fresh air. It exhales besides carbonic acid another and, as has recently been shown, a still more deadly poison. The air of an inhabited room is simply a solution of these poisons more or less dilute according to the means of ventilation employed, and is in a corresponding degree more or less poisonous to the inhabitants. Strength is reduced temporarily so that the best work is no longer possible, nerve force fails, pettishness and ill humour supervene, and resistance to evil temptations weakens. Whether repeated doses produce specific disease or merely lower the vital tone below its normal capability to resist those disease germs, "our invisible foes," which may be always

more or less around us, it is certain that consumption and other maladies follow directly the track of foul air in our habitations.

Dexterity is also to be cultivated if only to reduce the number of "thumby" people in the world, and as a means of general cultivation. Hence there should be manual instruction and practice in carpentry, metal work, clay modelling, etc. Hands are in some cases more capable than heads, and a boy who is a dunce at books may find hope and encouragement in the workshop that may cheer him to a victory over letters also.

Drawing, as the report of the Philadelphia Manual School says, is the first step in manual training. Freehand drawing—I mean really done with free hand—not the measured and patched work which sometimes passes under that description, is one of the best trainings for hand and eye.

In all subsequent operations such as work in wood, metal, or other material, if the pupil works to drawings, these should be made and designed by himself, and both the drawings and his work should be as accurate as he knows how to make them. No slippery work should pass, and so he should learn the beauty and satisfaction of thorough honest painful striving after perfection, leaving no stone unturned to gain it. Such work, quoting again the Philadelphia School, "fosters a high appreciation of the value and dignity of labour. Its moral influence is immediate and wholesome."

Destructiveness is a distressing fault in some young people. When once the trouble of *making* things has been learned by experience there is engendered a respect for the product of human labour which tends to abate both wanton and careless destructiveness.

Judgment is one of the most important of our capabilities. It may perhaps be defined as including observation, accuracy, discrimination, and reasoning power. Thring says "observation and accuracy define the whole range of a teacher's work." Manual work must cultivate these. How much of both would, for instance, be required in the attempt to turn a wooden sphere in a lathe. In a lecture on mental education Faraday remarks on the general deficiency of judgment, and attributes this to a

want of scientific culture. A kind of culture in which discrimination and reasoning power are in constant use. Shrewdness, a kind of judgment valuable in worldly affairs, would no doubt be cultivated by habits of observation coupled with the experience of natural responsibility for results.

Reasoning power or inference is most important, and for its cultivation has been recommended the study of language and grammar, or in a more perfect way, mathematics and the physical sciences including natural history subjects. Indeed that study of the things among which we live, and their order and meaning, which begins from the cradle, ought not to cease or be put in a subordinate place just when the mind begins to be more capable of appreciating its beauty and organizing it and profiting by it. Every school should have a laboratory for the study of elementary physics, chemistry, and biology.

Some of the best schoolmasters, remembering that there was a truer view of nature obtainable outside than in the pent up schoolroom, have made a practice of organizing expeditions for the study of natural objects under nature's own tuition. Her teaching is beautiful, and true, and life giving; but her "results" cannot be reckoned in coin of the realm, and so unfortunately she is not employed under the Intermediate Code.

The study of the heavens is also one which seems to attract much less attention than its value as a means of culture certainly deserves—I mean of course the heavens themselves—not mere books on astronomy with their dry descriptions and drier numbers. Every school should have a telescope. Even one of moderate power will show something of the glory and mystery of the great nebulae, the wonder of Saturn's rings, or the dignity and power of the giant planet Jupiter with his satellites and belts. From earth and air and sky, from all points we may draw powers of education, and the lifted feeling that made the Psalmist exclaim, "The heavens are telling the glory of God," has still power to draw us from the sordid ruts of habit to "look how the floor of Heaven is thick inlaid with patines of bright gold."

Originality will not be fostered by merely hearing or learning about what others did, nor will memory be strengthened by over heavy burdens. Self-respect, together with the social qualities, honour, gratitude, sympathy, veneration, can only be cultivated or increased by contact with high minded men such as the masters of every school should be, coupled with a system the reverse of those to which I have already referred. There is also much to be said on the subject of woman's influence in the schools—her intuitive sympathy, her high ideals, and as Thring puts it, "her weakness stronger than force, which ministers to true life."

Working in the same direction also, and filling up defects in the mechanical and scientific subjects, there is the humanising effect of an intelligent study of language and literature which makes also for the development of observation, accuracy, and imagination.

While there can be little doubt of the claims of the classics to some importance as a means of culture, I am inclined to think it is only in conjunction with other studies of a more liberal character that the subject is admissible, and that exclusive attention to the dead languages tends towards narrowness and pedantry. In considering their claims we must remember that the prestige attained in Europe by Latin and Greek (when at the time of the Renaissance they were re-discovered for the world, and were the only known means of culture) is perhaps too great in comparison with that of other means now available; and for the very reason that the dead languages gained this prestige when there was no other competitor for favour, we should examine all the more closely their claims as against other means now apparent. The study of words is supposed to have, as pointed out by Dr. Mary Jacobi in *Physiological Notes on Primary Education*, this advantage—that by it the child may be trained in the methods of physical science at a time when the pursuit of most physical sciences is impossible. It seems to me that the study of physical science (knowledge of material bodies) begins with the cradle, and Dr. Jacobi herself shows how a large amount of method may and should be im-

parted to this study years before the child begins to study words in learning to read. Sidgwick also in *Essays on a Liberal Education* says, "The very fact that the same instrument is made to serve various educational purposes which seems at first sight a very plausible argument in its favour is really for the majority of boys a serious disadvantage."

Thring thought classics the only means of real culture, but his argument seems to me weak, and he can scarcely be considered a capable judge, as he was, I believe, himself quite unacquainted with the sciences; and if it be true, as he says, that few comparatively arrive at any real application of the literary excellence of the classical authors it is difficult to see where their advantage as an educational study comes in. Mr. James MacAlister in his lecture on *Literature* thinks modern literature has at least equal value. At all events English and German, with their Shakespeare and Goethe, contain mines of wealth not easily exhausted.

I would here draw attention to the depraving of the literary taste of young children which goes on by cramming their minds with the rubbish that is inserted as "poetry" in elementary "Readers." The children call it "portry," an appropriate name, no doubt derived from the porcine nature of its authors. Here is an example from the *Royal Reader*. Compare it with "The Wreck of the Hesperus," "Casabianca," or "Battle of Blenheim," poems which a child of four can, after having heard them read a few times, learn to repeat, comprehend, and appreciate :—

1. "Butter is made from the milk of the cow,
2. Pork is the flesh of the pig or the sow,
3. Cork is the bark of a very large tree,
4. Sponge grows like a plant in the deep, deep sea,
5. Oil is obtained from fish and from flax,
6. Candles are made of tallow and wax,
7. Linen is made from the fibres of flax,
8. Paper is made from straw and from rags."

1. Butter is really a product of the cream only, and a child who does not know that much has no business learning to read.

2. A fine poetic sentiment beautifully put!

3. The cork tree is not so large as many other trees.

4. Sponge does not "grow like a *plant*," and the sponge of commerce is not found in "deep, deep" water.

5. The quantity of oil got from fish is not worth mentioning in comparison with that from other sources. Perhaps the "poet" thought a whale was a fish. Oil is not obtained from flax as understood by a "flaxen haired" child, but from flax seed—linseed.

6. Most candles are not now made from either tallow or wax.

7 and 8. Rags to be pronounced "racks" to meet the exigencies of this "poet," who has the temerity to call his production "Facts for Little Folks." "Platitudes for Partial Idiots" would be a less insulting title.

As twin sister to literature comes art. Since artists like poets are born, and not made—to a few only will it be worth while to teach art production. If taught at all, it should be with the practice of original design and an understanding of the scientific principles involved. But just as one may learn to appreciate literature without being able to write poetry, so one may be taught to value and understand painting, music, sculpture, architecture, and their leading points, their history and development, and the principles involved in and underlying these arts, thus giving an intellectual appreciation of their nature as well as a cultured enjoyment of the pleasure they give. The actual practice of music may however be considered as generally more desirable as a means of culture.

Now as regards mere knowledge; sometimes not inappropriately called dead knowledge. First, as to method of imparting it; the pupil is to be fed just as he can assimilate it, not stuffed like a Strasburg goose. What he learns then will remain and become part of him, and the process will be a comparatively easy and pleasant one.

Plato said the immortality of the soul appeared to him to receive decisive proof from the rapidity with which boys learnt. For they seized on knowledge so readily that they seemed to

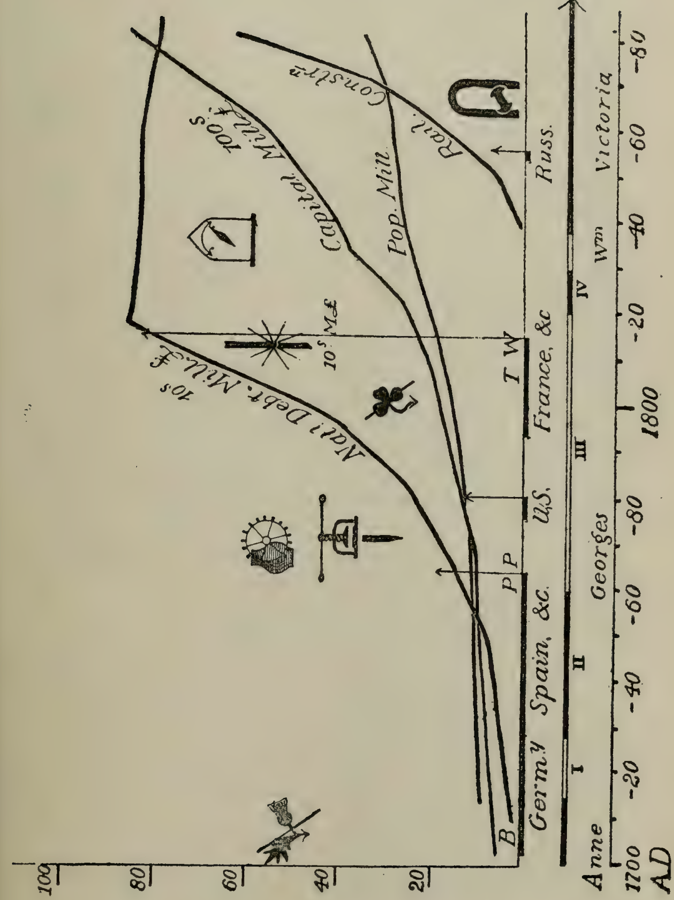
have come from a previous life, and to be picking up again what they knew before. But Plato's boys were probably not cramming a dozen subjects at once for which they had no appetite and which they could not digest.

As aids to ease of learning it may be remembered that just as the first written language was in the form of pictures, so the easiest way of imparting knowledge is by the graphic method. Every scientific investigator knows the value of curves representing the mutual variation of two quantities. At a glance one takes in the whole process, which would take hours to comprehend from mere numerals. How easily we see the meaning of the curve of barometric variation given on paper by the little aneroids so common now. How much more troublesome to understand and remember a set of numbers representing the same thing.

Similar curves may be employed in other studies. For example, in history as illustrated in Diagram III. where, with the accompanying graphic symbols, they will be found to convey to most minds, I think, a clearer and more permanent view of the whole subject, and its relations of time and magnitude than any written description. The line at the bottom of the diagram measures time, and is divided in decades from A.D. 1700 to 1880. On the next line above is indicated the duration of the various reigns, and above that, just under a line which forms the datum of curves, the great wars are shewn, with the cost of each represented by a vertical arrow-pointed line, each unit of which represents £10,000,000. A few of the great battles are denoted by their initial letters. The curves represent the rise and fall of several important National characteristics, including the National debt, capital, population and railroad construction. The impracticability of using a similar unit in the construction of all these curves is in some respects a defect, but it does not interfere with a study of their relative rise and fall as compared qualitatively with each other.

Various great events in history are indicated by their appropriate graphic symbols. The thistle "scored out" by a line drawn through it indicates the political extinction of Scot-

DIAGRAM III.



Nat'l Debt. Mill. £
10^s
Capital Mill. £
100^s
Pop. Mill.
Rail. Constr^n
10^s M £
B
Germ^y
Spain, &c.
P P
U.S.
T W
France, &c
Russ.
I
II
III
IV
Anne
Georges
W^m
Victoria
1700
AD
-20
-40
-60
-80
1800
100
80
60
40
20

land by her union with England—in like manner the shamrock, for Ireland. The establishment of potteries by Wedgewood in 1763 is indicated by the vase ; the invention of Hargreaves' and of Arkwright's spinning machinery, and of James Watt's steam engine is marked by the wheel. The press and pencil mark the advent of parliamentary reporting and the establishment of the newspaper press. The inventions of the electric light by Humphrey Davy, and of the single needle telegraph and dynamo are appropriately indicated.

As the diagram has been constructed simply to illustrate this application of the graphic method, much time was not spent on the choice of matters embodied in it. They were taken more or less at random from Mulhall's *Dictionary of Statistics* and Green's *History of the English People*. It is a remarkable fact that in the latter work no mention whatever is made of an event which had probably more influence on the progress and destiny of the English people—not to mention other peoples—than all the Royalties put together. I mean the invention of the locomotive by George Stephenson. We find a good deal about a comparatively despicable person called Stephen who was a king, and we have Georges—two of them not really "English people" at all, but no George Stephenson. Under letter L in the index we find about Lollards, but the locomotive might have been imported from China for all we are informed to the contrary.

Besides the use of such a chart as an aid to memory, it has the further advantage of giving much facility for the study of the causes interacting towards the variation of the characteristics indicated, and thus conduces to the rational study of history. The great rise of the National debt up to 1817 is evidently due to the war with France, etc. The rise of Capital is evidently accelerated by the invention of machinery, and perhaps also by the freedom of the press in the latter half of the 18th century. The increase of railways gives it a further lift upward. In a more complete chart such relations could be more generally and accurately traced. I am indebted to Professor Patrick Geddes for the idea of this kind of chart for

history. The plotting of similar charts of curves is a usual exercise now in some American schools.

DIAGRAM IV.

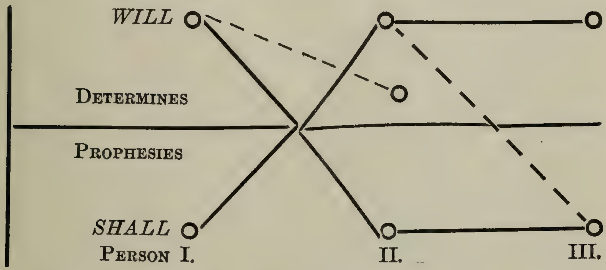


Diagram IV. illustrates the application of graphic methods to the study of grammar in the question of the proper employment of the auxiliary verbs "shall" and "will." It almost explains itself. The full lines indicate the common use of the words, dotted lines either partly obsolete, or newly forming uses, as "shall" in the old form of prophecy common in the Bible, e.g.—"He shall give His angels charge concerning thee." Also "will" in the form now used virtually as a command to an inferior whom we politely do not wish to impress with his inferiority, as "You will saddle my horse at once, please." This diagram also is not intended so much as an example of authoritative grammatical rules, as an illustration of the graphic method.

Geography of course lends itself specially to map making, but its teaching might be undertaken to even a greater extent by this method. I have often been told that cotton came from the Southern American States, gold from California, and wheat and maize from the Northern States, but I never had the localities of these products so clearly and indelibly impressed as by seeing for a few minutes in the Philadelphia Education Department a map, made by a student, where the cotton States were tufted with the real produce of the cotton plant, the gold States were

gilded, and actual wheat and maize glued over their appropriate places of production. I feel sure the maker of the map glued that information into his mind quite as firmly. The less printing or writing necessary on a map the more useful educationally it will be. The making of relief maps by piling up cardboards cut to contour lines, as practised by pupils in Switzerland, or by modelling in plastic material as adopted in America, is also excellent.

It seems to me that Geography is commonly learned in spite of, rather than by means of, the ordinary rote-work method. If the pupil has not a map before him, he must (to learn it intelligently) carry a map in his mind ; this implies, I think, a quite unnecessary mental strain. The well-known method of starting the geographical ideas of the pupil at the schoolroom door, and spreading out gradually into the world at large, might be called Nature's graphic method, and by it the science would be learned pleasantly and well. It would perhaps have been adopted before now, if it were not the fashion to have so much to do that there is no time to get even a little bit well done of everything that is necessary. We receive from Nature a hint of the appropriateness of this expanding method in the common schoolboy's trick of writing his address as A. B., of C. street, Belfast, Ireland, Europe, The World, Space.

The application of the graphic method to other studies will suggest itself. In all cases the charts should be made by the students themselves so as to increase their interest in them and impress the contents in the memory.

The optical lantern ought also to be a frequent adjunct to teaching. To read of Thermopylae is interesting. To see a view of the place itself would greatly increase this interest and would aid the memory. Now that photography has so vastly improved and cheapened the production of lantern slides there should be no real difficulty.

As has been pointed out over and over by various authors in various ways, the acquirement of knowledge should begin with the particular and obvious, and proceed through the general to

the abstract and profound, thus following the great biological law that individual development represents that of the race development of which the individual forms a part. In other words, we learn easiest by following the historical path by which the race attained its knowledge.

It is on this account that picture writing—graphic representations—should replace as far as possible written descriptions, and all experimental and observational subjects should be first studied by experiment and observation, beginning as Dr. Mary Jacobi puts it "with a few very striking and typical forms, around which subsequent knowledge can group itself," adding "it is a most dangerous preparation for the study of science to call upon children to imagine or represent to themselves facts which have not been apprehended by their senses."

This is also why grammar being an abstract science should, as has been repeatedly pointed out, be deferred till after language is known, and why it is so utterly absurd and impertinently pedantic to introduce into an elementary arithmetic book such abstract statements as "Proportion is the equality of ratios," a phrase once gravely quoted to me by a national school boy of twelve, who evidently had not the remotest idea of what he meant by it. It would seem almost superfluous to mention these things were it not abundantly evident that in the system of rote-work and hurry they are never thought of.

Respecting the subjects to be taught as mere knowledge, it has been well said that a man should know something of everything and everything of something. While carrying out each study well and thoroughly, so far as it goes, we must have variety of studies so as to preserve the mental equilibrium, and provide support and foundation for the one chief effort to which the organism is by nature best fitted. The discovery of this chief bent or capability is perhaps the most important duty of the parent or teacher. The neglect of it results in the everyday sight of square men painfully abrading themselves in round holes without result. Financial or worldly considerations and the personal hopes or desires of the parents ought here, I think,

to gracefully give place before Nature's command. If not, the only hope is that a strong genius will burst the repressing bonds and shoot into its proper place by the energy of its own explosion, a method which is at all events wasteful.

In regard to the relative importance of subjects in the "something of everything" class we may follow the order of Spencer. First, those relating to direct self-preservation should include sufficient physiology and hygiene, so as to give a chance of keeping in good health. Indirect self-preservation comes next: those parts of knowledge conducing to the attainment of a livelihood. Reading, writing, and arithmetic are the first needs. Arithmetical tables should be learned purely by rote, so as to be available without thought for immediate use when required. Any cumbrous short cuts of a so-called rational character, or of the nature of mnemonics, should therefore be avoided.

Among the more directly practical subjects may be mentioned some of the modern languages and book-keeping for boys, and household economics, cookery and dressmaking for girls. Then come principles underlying trades and occupations as the following, among which the pupil might take up as many and as much of each as he felt able for, mechanics, physics, chemistry: these should of course be learned experimentally, the student working out his own experiments, drawing his own conclusions, training hand and eye and mind at once: geography, studied graphically: economics, a subject on which there is too great a want of knowledge. Mathematics—especially geometry (not the empirical abomination called "Practical Geometry" taught by South Kensington Art Schools, but logical geometry), geology, botany, biology (these by actual observation of the minerals, plants and animals treated of), and astronomy, also by observation, as referred to before, are most important.

The next division is that of subjects relating to parenthood, perhaps more needed by girls than boys, including again hygiene, physiology, and the science of education, none of which, as I have already hinted, has been considered worth the study of the

ordinary mother. The breeding and training of horses or donkeys are matters which require knowledge and a special apprenticeship. For the *genus homo*, however, the one and the other would seem not worth the serious attention of people in general at all.

Next, for citizenship, we want history, not mere narratives of kings and queens and battles, but history of nations from which some idea may be formed from past phenomena regarding the results of present action. We want also economics and social science.

The last division, that relating to refinements of life, though last in point of mere necessity, is by no means of small importance otherwise, and it has already had attention at a former portion of the paper.

In the description of our proposed school I have referred a good deal to American models, especially to Philadelphia schools. There are in *The Century* for October last three papers on American Educational Institutions, one of which describes the Philadelphia Manual School, to which I have referred, and gives a splendid idea of the success of its training as a factor in general culture. I think a good deal of the excellence of these Philadelphia Schools is to the credit of their exceedingly able superintendent, Mr. James MacAlister, whom I have already mentioned; a gentleman whose enthusiasm in the cause of education I found most infectious, and who, although I visited him unintroduced, was good enough to give me nearly an hour of his valuable time in explanation of their aims and methods. A good deal also is due to the existence since 1881 of a body of some two hundred of the more cultured men and women of that city under the title of the Public Education Association of Philadelphia whose object is, as stated in its Report, "to promote the efficiency and to perfect the system of public education in Philadelphia."

Are we not here in Belfast rather behind Philadelphia in this respect? Do we as a general public, or as individuals, take that intelligent interest in this all-important subject which from

the well-known acuteness of the citizens of our modern Athens might be expected; or do we tamely and without question submit to that State devised and State controlled darkening of counsel which instead of education in these countries gives us

"The longing for ignoble things,
The strife for triumph more than truth,
The hardening of the heart that brings
Irreverence for the dreams of youth."

Are we not, dazzled perhaps by these long annual advertisements of Intermediate prize winners, forgetting that quick returns means mall profits; that though life is short, art is long; that the flower whose stamens have been converted into petals produces no fruit in the after time, and that the "idolatry of knowledge must cease or education cannot begin?" As Thring says—"This is certain, the schools of England will be good or bad according to the wishes of the homes of England."

Here and there one meets with men who know our desperate needs, and would fain see them supplied. But these are scattered. Would it not be possible to unite them? In these days we work by Societies and Conventions. The day of great personalities seems past, and the effort of many minds combined now takes their place. Will it be possible to do by this means for education what Luther did for the Church? To free it from formalities and immoralities and the dry husks of things; to take away mere authority and dogma and to bring in life and reason and moral growth; to sweep out fear and bring in love; to banish false issues and sophistry and cherish true interest in work and the dignity of labour for its own reward? It is for us to say if these things shall be.

DISCUSSION.

[The reporter's copy was sent to each speaker with a request that he would revise and, as far as convenient, condense it. This request was in all cases complied with, and the *Discussion* now appears as revised.]

THE CHAIRMAN, PROFESSOR LETTS.—Ladies and Gentlemen—I am sure that you will agree with me when I say that Mr. Brown has brought before us a most interesting and instructive Paper ; and that it contains much that is new and original.

I have not the slightest idea, however, as to what practical educationists will say regarding my friend's opinions. For myself, I may say that I fear some of his ideas are a little bit Utopian ; for he seems to assume that all young people are, more or less, angelic, while on the other hand his paper gives me the impression that he is of opinion that the older folks who instruct them are, more or less, the opposite. Many of us will, I suspect, be scarcely prepared to agree with him on this point. But I am quite sure of one thing, namely : that Mr. Brown's Paper opens up a wide field for discussion which, I doubt not, will be amply taken advantage of by the many eminent educationists I see present. I therefore invite them to speak.

PROFESSOR MEISSNER, (Queen's College) expressed his great pleasure at what he had heard from Mr. Brown, especially at what he had said respecting American schools. As to the injurious effects of the examination system, he did not see how we could get out of the difficulty. Our present educational system was the result of a political compromise. It would be necessary to change the religious and political ideas of people before attempting to change the present educational system. The practice of giving money-prizes at the intermediate examinations had created certain interests which it might not be easy to deal with. One of the objects of the Intermediate Education Act had been to assist schools in the poorer districts ; in this the Act had signally failed. The two schools in the North of Ireland which carried off the largest amount of prizes—the Belfast Academical Institution and the Methodist

College—were good schools before the Act, and their teaching did not require any extraneous stimulation. On the other hand the quiet and peace of school-life had been broken into. Instead of studying a subject, a certain book was got up, and the pupil prepared rather for the examiner than the examination. Formerly the candidates for the Indian Civil Service were prepared at the colleges, but at present the preparation of these candidates was a speciality of the so-called grinders. The elementary schools did not suffer in the same degree, as there was everywhere a sufficent number of pupils to keep up a good school; but where the mischief was done was in the department of higher education.

Dr. Steen (Royal Academical Institution) quite agreed with the Chairman's statement that Mr. Brown's ideas were utterly Utopian. He was about one hundred or perhaps two hundred years ahead of his time. He (Dr. Steen) however, believed the views put forward in the Paper were largely correct, and he might say that he had himself read a Paper some three or four years ago on the prize system, in which he expressed views analogous to those brought out that evening. The Paper was read before the Schoolmasters' Association, in Dublin, and he was sorry to say there was not one agreed with him. He argued it as Mr. Brown did, believing the system to be thoroughly bad, and he had not changed his mind on the subject, but perhaps that was an idea that would get hold of the public mind two hundred or three hundred years hence. He felt they were entirely on the wrong track on that subject, and he would like to see some school in the North of Ireland worked on the system laid down there that evening. What turned his attention to the matter was what he had seen in other countries, and especially in one country where the prize-system is practically unknown. He then began to study the matter and he came to the conclusion that it did not rest on a sound basis. But as Professor Meissner asked, what were they to do in Belfast? They must follow the lead of the Universities and Colleges and the difficulty had been increased one hundred fold by the introduction of the Intermediate System. As he

heard a gentleman saying, it used to be that they had a competition once a year but now there is a competition the whole year. It begins in January and goes on to December. He was pleased that Mr. Brown was so kind in his remarks with regard to the languages fearing that he might follow in the footsteps of the Right Hon. Robert Lowe, now Lord Sherbrook, and the late Sir James Simpson, of Edinburgh, who would denounce the whole system of language teaching, and go in for physical training which has received such attention for the last twenty years. He thoroughly agreed with the greater part of the paper, but believed it was Utopian. The children of those present, or their children's children, might see that principle in operation in the North of Ireland, but he thought it was not likely to be adopted sooner.

Mr. Armstrong, while holding the opinion that Mr. Brown's views were somewhat Utopian, entirely concurred with most of his ideas. He was much interested in the original diagrams exhibited on the wall, which were evidence of the labour and thought Mr. Brown had expended on the subject.

Mr. Adam Speers (Upper Sullivan School, Holywood) said that whilst he thought many of Mr. Brown's ideas on education Utopian, yet he agreed with a good deal of what had been said. He would not, however, admit that Mr. Brown's picture of the relations between teachers and pupils, at the present day, was a true one, or that modern methods produced paralytic idiots. He (Mr. Speers) also thought that much of what is called "cramming" nowadays by people who know no better, is really the best possible teaching; and if this be "cramming" there was a great deal of it going on in all schools where pupils are prepared for examination in prescribed courses. He believed that these courses are, as a rule, carefully studied by pupils, and faithfully taught by teachers. He ventured to say that teaching and learning of that sort should not be misnamed "cramming;" but teaching which has no higher aim than to enable pupils to pass examinations with the least possible knowledge, or with no real knowledge of the subjects, is "cramming." He was certain that the teaching was

excellent in most of the leading schools of Ireland, and there fore he did not submit to the imputation that our schools and colleges do nothing but "cram." He admired, however, Mr. Brown's able and witty lecture, and had no doubt that the suggestions thrown out would stimulate many to think more on the important subject of education. He (Mr. Speers) felt that there was still much room for improvement. In some schools, children were put to learn too many subjects at once. He knew that in England it was common to set children of six or seven years old to learn Latin and other languages. He thought that English, Arithmetic, a little Algebra, and the simplest facts of Modern Science, with Drawing and Penmanship, are the right subjects to occupy the mind of a child until ten or eleven years of age. He thought the education given in Irish schools would compare favourably, both morally and intellectually, with that in English schools, though not perhaps physically, since many English schools were full of nothing but football. He remembered once, while walking up the street at Eton, asking several groups of fine fellows belonging to the college there, what County Eton was in ; only one boy gave the right answer. What would be thought of an Institution boy who did not know whether Belfast was in Donegal Antrim or Down ?

Mr. Wm. Workman did not object to Mr. Brown's ideas as Utopian, because they ought to have a high ideal to work up to. The lecturer had given them such an ideal. Mr. Speers spoke about the ignorance of the Eton boys in geography, but if the history of England for the last hundred and fifty years were consulted, it would be found that England had made geography through the help of her Eton boys. In our present system of education, so far as he (Mr. Workman) could see, there was no attempt to develop vigorous bodies, and consequently no attempt to develop vigorous minds. In the Irish Schools there was an elaborate system of preparing for examinations which was mainly learning what other men have thought and which is more an exercise of memory than of the thinking powers. In one or two of the schools there is a gymnasium ; but carefully

closed during school hours, lest it should mar the result of the examinations, and only open afterwards when the boys are tired and hungry. Not one boy in five uses it. Football comes as an amusement but provides what is not attempted in school; a lesson in judgment, courage, and decision, also physical development; all invaluable for the success of the future man. He would also wish them to consider society as it exists. Manchester has been largely made from men with almost no education. When their profits were largest, men making fortunes did not know how to keep their accounts, probably could only read and write. Men at present in Belfast held leading positions in society who knew little else than the three R's. Some were idle at school, noted as mischiefs, but had physical vigour. With such facts before them they should be careful not to put too great value on "Education" as at present given.

Dr. Sheldon, Royal Academical Institution, considered that the two leading topics of the essay were the attitude of pupil and teacher to one another, and the advisability of examinations held by an outside authority, but before speaking of these he would say a few words on some of the other questions touched on by the essayist. (*a*) He agreed with the essayist that punishments could not drive knowledge into a pupil's head, but he would remind him that they might drive idleness out. (*b*) The essayist while speaking against corporal punishment had suggested no substitute. The speaker thought it preferable to the German plan of long detention in the school or in the home, and also considered it to be the most suitable punishment for some offences, such as bullying. (*c*) He could not agree with the essayist that a child's questions should always be answered. If the object of the child was to attract attention, then it should be repressed and if the information was accessible the child should be directed to seek it out; as a desire for knowledge was useless, unless a willingness to put forth effort accompanied it. Genuine questions with answers outside the scope of a child's reading should be answered. (*d*) As regards specialization of subjects, he thought this was for the

University student, not for the schoolboy, and that the Universities did harm by giving Entrance Scholarships in single subjects. A boy should leave school with a fair all round knowledge. The being obliged to do some work at a distasteful subject was a most useful discipline. A man who could only do what he "liked" would probably be a failure in active life.

Referring to the question of outside examinations, the speaker replied to some of the objections:—(*e*) no school that was successful year after year could push on the clever boys at the expense of the others, it would be a disastrous policy after two or three years. (*f*) "Cramming," or the unintelligent learning of text books could not exist in the face of good examining; the "cramming" school would soon be out of the race. (*g*) Pupils it was urged were kept too long at one book or (*h*) they had so much to do that they did not master their work. To these contradictory objections he would reply that when either of these results occurred it was the fault of those who drew up the syllabus and not inherent in the system. (*i*) As regards overwork, he had in a long experience only known two cases, and of both of these he gave details to shew that the fault could not fairly be attributed to the examinations. Parents should insist on their children going to bed at a reasonable hour. (*k*) He did not think that prizes caused ill-will and envy; all men work for some kind of prize and yet they may be consciously working to please their Divine Master. At the same time he would, with the essayist, keep emulation in the background, and would direct the pupil's attention rather to the maximum of marks than to those gained by his neighbour. Speaking generally he did not find that outside examinations hampered him. The chief influence on his own teaching was that an outside board selected the books the class was to study, instead of his doing so himself; as a rule the selections were good. He thought that the idea of giving up outside examinations was a retrograde one, as the institution of these examinations had undoubtedly immensely improved the schools of the United Kingdom and had prevented the stagnation that used to be so common. He believed too, despite the *Nineteenth Century*

Review, that the competitive system had been of great benefit both to the Home and Indian Civil Services. As to the other point the attitude of pupil and teacher, he would be brief—he quite agreed with the essayist that this should be one of complete trust, but he could assure him that trust existed in nearly all the secondary schools of the United Kingdom ; he knew no school in which distrust and ill-will reigned between teacher and taught. Of the primary schools he knew less but believed that the essayist's picture was too dark also for these. In the secondary schools he would repeat, we have at present exactly the attitude desired by the essayist.

Mr. James O'Neill said that education would never advance, *i.e.* children would never be truly educated, unless parents took a greater and more intelligent interest in their education. Hitherto parents have been fully satisfied if examinations were successfully passed, or prizes gained ; totally indifferent to the amount of education given, or whether "cramming" has been resorted to or not. Teachers have been more faithful to their duties regarding this matter of education than parents, despite every temptation to the contrary, and "cramming" exists much less than is thought. To whatever extent it does exist, however, is due to those arranging our Intermediate and University Curriculum, as the course prescribed cannot be learned in the time specified, unless in the case of those previously well taught in the given subjects ; so that the men appointed by the State to draw up our educational programme are much to blame in this matter. Let us now blame no more, but, as Mr. Brown has clearly, and I must heartily say, truly set before us the best method of gaining in the shortest time a true education ; let us avail ourselves of it. First, with regard to parents, let us shew them the advantages and pleasures of true education, by such means as our University Extension Lectures offer. Then let us next propose as our highest or ideal education for the young, a general knowledge of the external world, and also of man's work there, *i. e.* an intelligent knowledge of Astronomy, Geology, Botany, Zoology, and Chemistry, on the one hand ; and of History, and Litera-

ture, on the other. Each youth ought, in addition, to get specific training in whatever business or profession he intends to engage in ; as a farmer, in agriculture ; a doctor, in Chemistry and Physiology ; and so on. With reference to what Dr. Sheldon had said about distasteful subjects, he (Mr. O'Neill) would endeavour to make them as attractive as possible, knowing that attractive subjects are more easily learnt. He hoped Mr. Brown would give them his Essay in a permanent form.

REPLY BY THE ESSAYIST.

Some at all events of the foregoing criticisms would not perhaps have been requisite, if there had been time to read the whole paper before the Society. On account of its length portions were unavoidably omitted. In preparing it for the press a few small additions and some re-arrangements have been thought appropriate. These do not, however, alter the gist of the matter, except in relation to the study of language where I feared I might seem to advocate that study as sufficient for an almost complete early mental training ; a view which I do not hold. I propose to include here, along with the essence of my remarks at the meeting, a more complete reply to these criticisms as well as to others that I have received from friends at a later period.

While acknowledging the very kind and friendly way in which Professor Letts has expressed himself, I should like to convince him and several of the other speakers that my views are not quite Utopian, a word which I find defined as "an ideal perfection, fanciful, impracticable." Most of that part of the essay relating to the early training of children is drawn from experience of actual children, my own* and those of others.

*It is difficult to refer to personal matters without a seeming egotism. It may be remembered, however, that one can learn from the failures as well as the successes. In so far as the training applied to these children has been successful, and for its execution, it is right that I gratefully acknowledge my indebtedness to the lady who has charge of them. I have besides to express my obligation to Miss L. Kertland for much kind help in preparing and revising the paper, and to my friend, Mr. H. C. Montgomery, for his careful correction of the proofs.

Then the system advocated must be taken as a whole. It would be unfair to give a boy an early training under the not unusual method of repression, cajolery, and bribery, and then expect him to fit perfectly the methods advocated for school systems. We do not gather "grapes of thorns, or figs of thistles." The essay touches a few points only, which, however, I have tried to make parts of a consistent system, and only in so far are they at their best. Nevertheless, there are, as pointed out already, actual Schools in America and England, and there is also one in Ireland, where some of the methods advocated are employed with the happiest results.

The remark of Professor Letts regarding "older folks" gives me the opportunity of expressing a hope that I have not used language of unnecessary strength. I wrote as I felt, and I do feel that under the conventional systems there lurks much unnoticed traditional evil. Of other shortcomings in the essay I am very conscious ; yet, if it draw some attention to the need of reform on matters so important, its existence will be justified. With the views expressed in Professor Meissner's graphic reference to the effects of the Intermediate Education Act I cordially agree. Respecting the difficulty in changing the present system which he points out, we may hope that the present system will change when it no longer receives public support. "The schools of England will be good or bad according to the wishes of the homes of England,"—so will the schools of Ireland. The observations of Mr. James O'Neill show that he concurs in this view, in connection with which I would refer to some excellent passages towards the end of Mr. Auberon Herbert's summing up in *The Sacrifice of Education to Examination*, especially where speaking of attempts to devise State controlled systems he says "at last the irresistible truth will break upon us, that not in one thing but in all things, good work and the compulsion of each other lie at opposite poles;" and he goes on very ably to advocate free trade in education (as in commerce) based on general intelligence born of the activity of the people themselves, as opposed to protection and authoritative systems.

The adoption of Mr. O'Neill's suggestion that cramming

might be decreased by the giving of easier courses for the Intermediate and other examinations would not, I fear, have the desired effect. It would lead simply to a greater percentage of crammed stupid people on the pass lists. The logical sequence of an improvement of that kind would be the bribing of all scholars whatsoever.

Dr. Steen's remarks, coming from one of the masters of my own old school, are exceedingly encouraging and helpful. I trust there is more hope for the immediate future than he entertains.

Mr. Workman also is with me, and I am grateful for his sympathy. His remarks are much to the point, though I deprecate his use of the word "education" as applied to the present system of school-work.

Mr. Speers and Dr. Sheldon will, I hope, pardon me if I suggest that the views they uphold might be broader, and that possibly those who are not so much immersed as they in the details of particular systems, do frequently see something well worth attention outside the systems which these gentlemen so stoutly defend. Nevertheless, I felt there was in Mr. Speers' criticism an undertone of sympathy with what I should consider true methods, and I thank him for his approval of my effort to direct attention to the subject. I fully agree with him that Irish boys are, generally speaking, more moral than English boys : this is well known. But I would add to Mr. Speers' curriculum some training for the body also. The race learnt labour before letters, and the young of the race should probably follow the same historical course. It is also impracticable to acquire dexterity unless it be learnt early.

Dr. Sheldon, in revising his remarks, has kindly divided them into sections, which may be considered separately. To *a* and *b* the reports from American schools at pp. 18, 19, are perhaps a sufficient answer. Persistent bullying is one of the results of bad training referred to at p. 18, and can perhaps in some cases be cured only by the rod ; but for minor

offences, I am inclined to agree with the view expressed in George Arnold's lines :—

> "The rod was hardly known in his school—
> Whipping, to him, was a barbarous rule,
> And too hard work for his poor old bones :
> 'Besides it is painful,' he sometimes said ;
> 'We should make life pleasant down here below,
> The living need charity more than the dead'
> Said the jolly old pedagogue, long ago."

Respecting *c*, if the child asks questions *merely* to attract attention, he does so owing to faulty training in other respects. He has been allowed to become vain and inconsiderate ; or he is naturally but unskilledly striving to relieve himself from the very repression that is thought so suitable. The remedy is obvious. A child who is hungry will cry for food, be it mental or bodily food ; and if habitually hungry will habitually cry ; may get a habit of crying, which he will continue whether hungry or not : but a naturally fed child is likely to be naturally quiet. It is quite true that children should be encouraged at a later period to think out answers to their own problems. This I may say is my plan with my own boys, and it is referred to at p. 14, a part of the Essay which was (but perhaps ought not to have been) omitted when reading it. The questions I meant to refer to begin before the child can speak plainly, so that books are not available to him. I would agree with the opinion expressed in *d* regarding specialization, but not that there is any moral discipline for true life in "obliging" a boy to do distasteful work : I presume that obliging by threat of punishment is meant. I think Dr. Sheldon rightly objects to the doing only of what one likes, *i. e.* what one likes irrespective of others, or of future consequences. But likes and dislikes are comparative, and the boy in the case really does the work because he likes it—better than a caning. The need of doing what is not presently easy or agreeable is admitted, but I prefer a higher and more manly motive. I think with Mr. O'Neill that we should make learning as easy as possible. I prefer to boil my peas if I must do penance with them in my shoes.

I find some difficulty in replying to *e*, *f*, *g*, *h*, for want of an accepted definition of the phrases "a successful school," "the race," "good examining," and of the syllabus that would suit every possible kind of boy. It is quite true (*i*) that parents should see that children are not overworked at home: but why have a system such that the parents have to interfere with the tendency of the school influence? I quite think there should be less home-work; in fact agree with a lady friend's suggestion that the "teachers" should "teach" her boys their lessons, and she would have much pleasure in hearing them. To discuss (*k*) the broad question of human motive would occupy too long, but assuming that this is generally individual profit or advantage, I think it will be admitted that to work for the advantage conferred by the work itself, as in the American schools, is a higher motive and forms a better training than working for a bribe, in the sense of a reward not actually a product of the work performed.

I am glad that Dr. Sheldon deprecates emulation or competition in schools. Though competition is, according to Darwin, the plan by which Nature builds, and though one usually thinks it right that the best man should win, I believe it is, partly at least, because under the present examination system often the best man does not win, that competition is to be deprecated. Memory and "knack" win, but mind is often beaten; and it would seem that the success of memory without mind tends to a somewhat egotistical product. I may note here, as perhaps in part due to this, a certain tendency toward egotism in modern literature. The older scientific writers, for instance, had sympathy: they talked *with* you: they loved their subjects, and loved you because you loved them. The modern Doctor of Science lectures *at* you.

Egotism seems to be a fashion of the age, which education might well discountenance in returning towards the habit of an older time. Consider the difference between Shakespeare and Tennyson. In the *abandon* of the older writer the ego is so invisible as to permit his very individuality to be doubted. He may be Bacon: he may be somebody else. He has been

thought to be a mere spirit of the time crystallized into poetry. But the modern writer's hypochondriacal ego is imminent in every page.

Dr. Hime, of Foyle College, Londonderry, criticises my views in a letter published in the *Northern Whig* of 23rd January last. He is of opinion that the intermediate examinations do a great deal of good to the boys and masters concerned, and no harm, and he "seldom or never heard of any successful Irish intermediate schoolmaster who condemned the present intermediate system." The opinion of a man of Dr. Hime's experience and ability necessarily carries weight. I have, however, so far as I know, only met with one intelligent parent, not a professional teacher, who held the same view. I have met very many, both in and outside the profession, who were of an opinion exactly opposite. One could scarcely expect a "successful intermediate schoolmaster," who was not more than human, to quarrel with his bread and butter. I would advocate a liberal supply of these, but given on a different method.

Dr. Hime says the "intermediate examinations stimulate and encourage us all immensely:" I would ask—towards what do they stimulate? He speaks again of the increased percentage of "distinguished University students." I would ask—for what are they distinguished? And I do not ask these questions in any cavilling spirit, but to point to what I believe to be a continually growing tendency on the part of the profession, one which I think is fostered by the examination and prize system; a tendency towards a definition of the goal or aim of school-work quite different from that adopted by the intelligent laity.

I think schoolmasters, and consequently schoolboys, would be nearer the perfection which Dr. Hime also desires, if the former were chosen out, not so much for their knowledge, as for their power of true education, which is a very different thing.

Dr. Hime, as would be expected, is with me in condemning corporal punishment.

My friend, Mr. Donald Cameron, of Exeter, to whom I had sent the newspaper report of my essay, thinks there is need in it of a definition of the meaning I attach to the word "knowledge," a word which he says "a non-philosopher of Scottish nationality defined as an 'act or operation of the mind.'" Though I admit the aptness of the criticism, I do not agree with the "non-philosopher" in his definition of knowledge, the meaning of which I find given in the dictionaries as "perception, learning, information, acquaintance, cognizance, skill." It is in the sense as connoted by the first five equivalents that I have used the word, and I think my critic will concede that there are many operations of the mind which are not knowledge in this sense. Nor is the power for their performance cultivated by the acquirement of knowledge. In mental education it is for the cultivation of these powers I plead.

APPENDIX II.

NOTE TO

PAPER ON THE THEORY OF THE SCREW PROPELLER, READ BEFORE THE BELFAST NATURAL HISTORY AND PHILOSOPHICAL SOCIETY, ON MARCH 4, 1890, BY M. F. FITZGERALD, M.I.M.E.

THE water is throughout considered as flowing past the propeller, whose only motion is one of rotation about its axis. The principal symbols employed are as follows:

K=velocity of water past the propeller, taken to be, at a distance from it, in lines parallel to its axis; in other words K is the speed of the ship through the ocean.

v=velocity of water at the propeller, resolved parallel to its axis.

x=distance measured along as parallel to axis of any point from a fixed plane at right angles to axis, say for instance from the plane of the after end of the stern tube.

r=radial distance of any point from the axis of the screw.

Ω=angular velocity of the screw; so that at radius r the circumferential velocity of the screw is $r\Omega$.

ω=angular velocity of the water; so that at radius r the circumferential velocity of the water is $r\omega$.

R=radius of screw disc, *i.e.* radius to tip of blades.

It is much shorter to express the circumferential velocities thus than to say, "let N be the revolutions per minute, and let D be the diameter of any circle drawn on the screw disc; then the circumferential velocity of the screw at this place is 3·1416 DN feet per minute or 0·05236 ND feet per second"; and then afterwards be always dragging in this abominable 0·05236 everywhere.

The circumferential velocity of the water is not actually the same at all points on the circumference of the same circle; but hereafter ω is understood to mean the average angular velocity at any given radius. Neither is the circumferential velocity of the water the same at different distances from the axis; and it is the purpose of this Note to point out by what rule this is governed, approximately. Similarly for v, the longitudinal velocity. This, in the ordinary theory of the propeller is assumed to be uniform, or nearly uniform, over the whole screw disc. In this Note this assumption is shown to be, for practical purposes, correct, though not necessarily true absolutely. It is furthermore assumed in this Note, that the ordinary mechanical law, that a loose, or free body, when acted on by a force for a given time, will have a quantity of motion generated in it proportional to the force, and in the direction of that force, irrespective of the previous direction of motion, or velocity, of the body, is true, and that the application of this law, as commonly employed in calculating the power developed by turbines and other engines worked by the impulse of water, is correct, and justified by the fact that in such engines the power calculated on comes out right in practice. There is absolutely no novelty in the principle, or its application. It is furthermore assumed that when a liquid flows in a closed pipe or tube the head, or pressure of the liquid, varies if the velocity of flow varies, in accordance with the ordinary established law that the change in the head is proportional to the difference of squares of velocities, from point to point. It is furthermore assumed that an incompressible liquid, flowing along a full pipe, will vary in velocity at different places in accordance with the cross sectional area of

the pipe, totally regardless of all other circumstances whatsoever. In other words, if the flow at one cross section of a pipe be ten gallons a minute, it is ten gallons a minute at every cross section of the pipe, and the velocity is therefore fixed absolutely if the cross section be known. From this it follows further (as is well known, and has been held to be well known and established ever since the days of Toricelli, a period of some two hundred and fifty years, neither is, or is conceived to be, any novel or fresh doctrine, nor has been found to be in discordance with the facts of experience) that given the head and velocity at any one point in a tube filled with incompressible fluid flowing along it, then both the head and velocity will be (except for friction) fixed at every point along it by the cross sectional area, and *vice versâ*; the head or pressure, and velocity, being indissolubly connected together. It is furthermore assumed that when a body moves in a circle, the centrifugal force is directly proportional to the square of its circumferential velocity, and inversely proportional to the radius, and this doctrine is at least as old as the days of Sir Isaac Newton, say two hundred years, and the sun and moon, and the earth and the planets and the comets, have been moving in accordance therewith since a time that the memory of man runneth not to the contrary, neither has this doctrine been ever found to be in discordance with the facts of experience.

The principal reasons why the known, acknowledged, accepted, acted upon, and practically successful theory of turbines has not, so far as the author is aware, been applied in exactly the same way to the case of screw propellers are these. The first is, that the persons who had to make the calculations for, and apply their results to, turbines, were not usually the same as those who deal with propellers, and, when the true mechanical theory of turbines was first brought out, the persons who did so could not possibly have concerned themselves with screw propellers, the same not being then in use, or even perhaps invented. The second is that in the case of turbines the work done by the rotary force is the only matter of importance, and the end

thrust, when there is any, is objectionable and more or less avoidable ; whereas in the screw the end thrust is desirable and is a matter of the greatest importance, its determination masking altogether the question of the determination of the rotary force. The third reason is, that, in order to provide, if possible, convenient rules for the construction of propeller blades, and partly in consequence of the rough theory of screw and water conceived as bolt and nut, the pitch of the screw has been dragged in, neck and crop, into all sorts of matters with which it has only a very indirect concern. The purpose of this Note involves the determination, approximately, of the rotary force, in screw propellers, and the consequent inference of the end thrust, which is not separately determinable at all ; neither is there any novelty involved in conceiving the thrust of the shaft, and turning moment of the engine, to be in some way connected together, neither has this doctrine been found to be in discordance with the facts of experience.

Let Fig. 1, then, represent in plan, the stream lines of a ship's body, and propeller ; the lines ASA' being the boundaries of a tube of flow. If, for simplicity, and as is usually done in the accepted way of treating of the thrust of a propeller, it be assumed for the present that the velocity of flow is the same at every point of the screw disc at SS, then in accordance with the accepted laws of mechanics and the usual and accepted doctrine of the thrust of propellers, if the velocity at SS be v, and be greater than K, the speed of the ship ; and if Q be the quantity of water (expressed as the weight of so many cubic feet for instance) flowing per second through the screw disc, the thrust is $Q\frac{(v-K)}{g}$ lbs., and as this is produced by a flow of Q lbs. it is equal to $\frac{v-K}{g}$ lbs. per lb. of water flowing through the screw disc per second. So far the ordinary theory in effect states, that, conceiving the part of the tube of flow ASA' which lies to the right of SS as the nozzle of a jet propeller, which contains the ship, like a fixed obstruction inside the nozzle, the propelling

force acting on the whole nozzle AS is $\frac{v-K}{g}$ lbs. per lb. of water per second flowing through the screw. Turning then to the remainder of the nozzle, to the left of SS, the water passing through the screws ultimately looses its extra velocity, and in so doing, produces a backward pressure (viz. from S to A') on that part of the nozzle. In the case of a pure and simple nozzle immersed at a great depth in an infinite ocean the backward and forward pressures would be equal, and the neck of the nozzle at SS would be continually lengthened by the separation of the forward and after parts, AS and SA', of the nozzle by the forces acting to separate them, were there not a disarrangement of the motion of the surrounding water near SS, whereby such changes of pressure or "head" would occur as to produce an equal tendency to prevent the separation of AS from SA', and the whole tube of flow ASA' would be, on the whole, acted on by no forces, and therefore remain of fixed form in a fixed position, with the water flowing past and in it. When, however, there is a propeller at SS setting the water revolving the motion of the water in the part SA' of the tube of flow will be different from what it was in AS, and additional forces will exist, due to centrifugal pressures, which may be (and in the case of the propulsion of a ship are) able to keep the obstruction (that is the ship) in its place in the nozzle AS, and to provide in addition for the expenditure of energy required by the ship and nozzle ASA' causing waves to spread continually out into the ocean (as they must do when the ship, &c., are near the surface) and to overcome frictional and other subsidiary losses of power. The extra thrust, due to the circumstance of the ships body forming an obstruction in the nozzle AS is familiar under the title of "added resistance" in screw vessels.

In one sense, the efficiency of the screw is the ratio

$$\frac{\text{work expended on thrust}}{\text{Total work done.}};$$

but this is not the same as the commercial efficiency, the latter being

$$\frac{\text{work to keep obstruction in place}}{\text{Total work done}},$$

and is smaller than the former, though perhaps not much smaller in some cases, and we have no direct means of calculating it. It is manifest that all questions arising from proximity to the ship's body, surface disturbance produced by the screw, frictional and displacement resistance, and so forth, must be left out of account in giving a theory of its action in any tolerably simple form, just as similiar sources of loss are in making a preliminary estimate of the horse power of an engine. The screw will therefore hereinafter be treated as if the blades had no thickness or surface friction, and as if it were sufficiently deeply immersed to produce no surface disturbance. The effect of the latter cause has been found, by experiment with screws much more deeply immersed than is usual, to be practically insensible, or at any rate trifling, so long as the screw does not break the surface.

The water has originally no rotary motion, and in the case of screws fitted in the usual place, this applies, in all probability even to water quite close to the screw ; whether or no, the rotary impulse is $\frac{r\omega}{g}$ lbs. per lb. of water per second entering the screw at radius r, and acquiring a circumferential velocity $r\omega$. In the theory of turbines $r\omega$ is called $v\cos a$, v being the velocity of issue from the guide blades, and a their angle of inclination to the plane of the buckets ; $\frac{r\omega}{g}$ is therefore the pressure of the screw against the water at radius r, in lbs. per lb. of water per second flowing through at that radius ; the screw itself moves with velocity $r\Omega$ at that radius, and the work done is therefore $\frac{r\omega}{g} \times r\Omega = \frac{r^2\omega\Omega}{g}$ lbs. per lb. per second, just as in a turbine the work done by the water is $Vv\cos a$, V in this case standing for the circumferential velocity of the bucket wheel, or turbine itself. See any treatise on turbines written (except by lunatics) in the last fifty years, or thereabouts. In accordance with the notation and principles known and applied to such matters since the days of Des Cartes (some two hundred years) the

number of lbs. per second flowing through a narrow ring on the screw disc, between radii r and $r+dr$ is equal to $2\pi v r \rho dr$, where ρ stands for the weight of a cubic foot or other standard of length; consequently the work done, in foot lbs. per second, between radii r and $r+dr$ is

$$dP=2\pi v r \rho dr \times \frac{r^2 \omega \Omega}{g}=\frac{2\pi\rho}{g}\Omega v r^3 \omega dr.$$

and the total horse power, one horse power being 550 ft. lbs. per second, is

$$H.P=\frac{2\pi\rho\Omega}{550g}\int v r^3 \omega dr$$

the limits of the integral being outer radius and radius of boss. If we now knew the values of v and ω at each point on the screw disc, we could find the value of this integral. If furthermore we could express v and ω in terms of r algebraically in certain known forms, we could calculate the power by the rules of arithmetic, and if we could not express v and ω in terms of r in such a way, still we could draw curves of their values, and find the value of the integral by the aid of a planimeter.

In the case of a turbine matters are much simpler, for v and ω are, if not exactly, very nearly, constant, so that the troublesome part of the process is avoided, for the most part, otherwise the case is the same as that of the propeller, only of course the work is done by the water on the turbine, instead of by the turbine, otherwise called the propeller, on the water. In this last respect the difference may be paralled by the work done in the case of a truck running down an inclined plane, and doing work while so doing, which work is the same as that required to pull the same truck up an inclined plane; and there is nothing novel, or contrary to any previously known or accepted doctrine, or to the facts of experience, in the application made above of the theory of turbines to the case of propellers; but on the contrary, all who have said anything on the point at all, have described propellers as, in effect, turbines driving water, instead of driven by it, and only differing from ordinary turbines in not having guide blades to give the entering (or in propellers the outflowing)

water a previously determined velocity and direction, and in having no surrounding casing.

As previously stated the thrust is $\frac{v-K}{g}$ lbs. per lb. of water per second flowing through the screw at any point by the ordinary theory, and the total work done is this multiplied by $\frac{v+K}{2}$, longitudinally, which amounts to $\frac{v^2-K^2}{2g}$, or half the change of *vis visa*, in accordance with the usual accepted laws of mechanics; likewise the work done circumferentially is $\frac{r^2\omega^2}{2g}$, and radially, if there be any radial flow, $\frac{r^2\omega^2\tan^2\psi}{2g}$, where ψ stands for the angle made with a tangent to the circle of radius r by the actual path of the water, projected on the screw disc. This can be seen by inspection of Fig. 2, which represents isometrically the motion of a particle of water at A in the direction, and with the velocity, AD, the angle ACD being ψ. AC is v, the velocity resolved parallel to the axis, CB is $r\omega$, the circumferential velocity; and BD is $r\omega\tan\psi$, the radial velocity.

The whole work done is done by the engine, and consequently we can equate the sum of the longitudinal, circumferential, and radial, work to that done by the engine at radius r, which has been previously shown to be $\frac{r^2\omega\Omega}{g}$

giving $$\frac{r^2\omega^2}{2g}+\frac{r^2\omega^2\tan^2\psi}{2g}+\frac{v^2-K^2}{2g}=\frac{r^2\omega\Omega}{g}$$

Multiplying this across by $2g$, and writing $\frac{1}{\cos^2\psi}$ for $1+\tan^2\psi$

gives $$\frac{r^2\omega^2}{\cos^2\psi}+v^2-K^2=2r^2\omega\Omega.$$

It may be well to note that it is unnecessary to take account of the circumstance that the point D may be higher or lower than A, so that there may be work done against gravity when, as in a screw propeller, the axis is horizontal, because if D be (as in the figure) higher than A, there is, at the opposite side of the

circle, a corresponding particle of water for which D is as much lower than A, so that if gravity helps the one, it resists the other to an equal extent, and this is true whatever the hydrostatic pressure may happen to be, so that the equation just found is equally true for all depths, and whether the axis of the screw is horizontal, vertical, or inclined, provided that the general surface of the ocean is undisturbed.

In the case of a turbine, the general surface is not undisturbed but may be thirty or forty feet higher at one side of the turbine than at the other, the difference of level being in fact the source of work done on the turbine by the water when employed as a source of power, and *vice versâ* in the case of a centrifugal pump.

The equation just found is an important one, as it connects together the circumferential speed of the water, $r\omega$; the longitudinal velocity, v; the speed of the ship, K; and the circumferential speed of the screw, measured by its angular velocity Ω; and this equation, like the corresponding one for a turbine, is the fundamental one governing these quantities, which is therefore one condition they must fulfil, irrespective of all other circumstances.

It appears at once that if $\omega=0$, *i.e.* if the water have no angular velocity imparted to it, $v^2-K^2=0$ and therefore $v=K$, so that, as the thrust is proportional to $v-K$, there is no thrust. That is, *if the water be not made to revolve, there is no thrust.* Consequently any design of blade intended to prevent, or avoid, rotary motion of the water, would, if successful in so doing, also prevent any thrust being obtained, or any power being consumed, except in friction.

The next thing to be considered is the head or pressure, at various points in the screw disc, the head being less as the velocity is greater, by a law previously mentioned. Suppose the head at a point, somewhere at a long distance from the screw, in the tube ASA', where the velocity is K, to be H, then if the the velocity at radius r, is called u, (u being now AD, the actual velocity in the actual direction of motion of the water) then

$2g(H-h_1)=u_1^2-K^2$ and at r_2 similarly

$$2g(H-h_2)=u_2^2-K^2$$

h_1 and h_2 being the heads r_1 and r_2 respectively. The same arguments apply as before for the cases of the axis of the screw being vertical, horizontal, or inclined, and for particles at opposite ends of the same diameter, &c. Subtracting one of these equations from the other, and supposing r_1 and r_2 to be two radii nearly equal, containing between them a ring on the screw disc of infinitesimal breadth dr, we get

$$-2g\frac{dh}{dr}=\frac{d}{dr}(u^2-K^2)$$

By geometry, in Fig. 2, it appears that u^2 is equal to $\frac{r^2\omega^2}{\cos^2\psi}+v^2$ the angle ACD in the triangle ACD being a right angle, so that $u^2-K^2=\frac{r^2\omega^2}{\cos^2\psi}+v^2-K^2$ which is equal to $2r^2\omega\Omega$ by the fundamental equation previously found. We have therefore, equating these and dividing across by 2

$$-g\frac{dh}{dr}=\frac{d}{dr}r^2\omega\Omega$$

But again, since the water is moving in a curved path (both longitudinally and circumferentially) we have also

$$g\frac{dh}{dr}=r\omega^2-\frac{d^2r}{dt^2}$$

where $\frac{d^2r}{dt^2}$ is the radial acceleration of a particle in its longitudinal path, and can therefore be written otherwise

$$\frac{d}{dt}\cdot\frac{dr}{dt}=v\frac{d}{dx}(v\tan\theta),$$

where θ is the angle made by the boundary of the tube of flow ASA', or any similar inner tube of flow at radius r, with the axis of the screw. We can, on comparing the last two equations, get rid of $\frac{dh}{dr}$, since we are not interested in the value of the head, or pressure of the water hydrostatically, and, substituting for $\frac{d^2r}{dt^2}$ its value just mentioned in terms of v and $\tan\theta$ we get

$$-\frac{d}{dr}(r^2\omega\Omega)=r\omega^2-v\frac{d}{dx}(v\tan\theta)$$

Here again Ω is an independent arbitrary constant, being the screw's angular velocity, and consequently the same for every point whatsoever, so that dividing across by it we get the equation in the form

$$-\frac{d}{dr}(r^2\omega)=r\omega\frac{\omega}{\Omega}-v\frac{\frac{d}{dr}(v\tan\theta)}{\Omega}$$

in which all the terms are of the dimensions of velocities.

The stream lines of the screw converge towards it from the ship, and diverge again behind it, consequently (except near the boss) they must be, in the screw, approximately parallel to the axis. This means that $\tan\theta$ is small, except near the boss. The amount of thrust in practice is found to agree pretty well with the amount of longitudinal slip, proportional to $v-K$ supposed uniform, consequently (except, as before near the boss, where only small quantities of water, having but a slight influence on the result, are dealt with) v exceeds K, but, in practice not much, and cannot therefore differ much at different radii, consequently $\frac{\frac{d}{dx}v\tan\theta}{\Omega}$ is small numerically if the stream lines if the screw be tolerably fair and not sharply curved in the screw itself. It is likewise observable in practice, and agrees with calculation, that the angular velocity of the water is, except as before stated, near the boss, for the most part but a small fraction of the angular velocity of the screw. It is also observable, and agrees with calculation that in the outer tube of flow, the curve ASA' at the screw is convex to the axis of the screw. Consequently, for the most part of the screw disc, the equation

$$-\frac{d}{dr}(r^2\omega)=r\omega\frac{\omega}{\Omega}-v\frac{\frac{d}{dx}v\tan\theta}{\Omega}$$

consists on its right hand side, of the difference of two terms, both of which are small; and therefore the result of that equation, whatever the precise values they may have may be, must be approximately expressed by $\frac{d}{dr}(r^2\omega)=0$ which being integrated

gives $r^2\omega$=a constant, namely its value at the outer circumference of the screw, denoted hereinafter by $R^2\phi$.

The Table of Horse Power has therefore been calculated on the hypothesis that $r^2\omega$=a constant, and that v is also constant, and therefore the same throughout as at the outer circumference. From the fundamental equation we have for this, by transposing $\frac{r^2\omega^2}{\cos^2\psi}$ and K^2; also assuming that ψ is not large enough to make it necessary to take into account that it is not unity (for instance if ψ were 20°, $\cos\psi$ is 0·94 and as $R\phi$ is small, seldom exceeding 0·08 of $R\Omega$ or 0·32 of K, its exact value to a decimal has little influence)

$$v^2=2R^2\phi\Omega+K^2-R^2\phi^2$$

and, for the Horse Power

$$H.P.=\frac{2\pi\rho}{550g}v\Omega\int r^3\omega dr=\frac{2\pi\rho}{550g}v\Omega r^2\phi\int rdr$$

$$=\frac{2\pi\rho}{550g}v\Omega R^2\phi\left(\frac{R^2-B^2}{2}\right)$$

where B stands for the radius of the boss, taken to be one-fourth of the radius of the screw in calculating the Table.

The calculated results could only exactly be true, therefore for a special screw, designed to fit the vortex assumed; but, as above shown, they must be approximately correct (exclusive of friction) for any screw having reasonably fair stream lines over the outer parts of its disc; and the examples mentioned in the Paper show that, on calculation, this is so. The curves of values of $r\omega$ and v for the case where $R\phi$ and K have the values shown are drawn in Fig. 3, the former being denoted by the curve TT.

A special form of the vortex occurs when $\frac{d}{dx}(v\tan\theta)=0$ throughout, *i.e.* for a straight cylindrical vortex. In this we find

$$\Omega\frac{d}{dr}r^2\omega=-r\omega^2$$

for the equation of the curve of values of $r\omega$. On integration this equation gives $\frac{r^2\omega}{2\Omega+\omega}$=a constant, and the curve is drawn in

Fig. 3, being the curve BT, and the corresponding values of v are shown in addition. This curve, even when, as in the figure, $R\phi$ is so large as 0·08 of $R\Omega$, differs but little from TT till a point about two-thirds of the way in from the circumference to the boss is reached. Only about a fourth of all the water passes through the space inside this ; it would be exactly a fourth but for the slight increase in v, amounting to about one-seventh of its value at the greatest, and for all cases where $R\phi$ is less than 8% of $R\Omega$ it is much less than this. A small portion of a Table of Horse Power, corresponding to the case where $R\Omega=2K$ has been calculated for this curve for the different values of $\frac{R\phi}{R\Omega}=\mu$, and is subjoined, the variation in the value of v being neglected, and the boss taken to be of such a radius that $\omega=\Omega$ at its surface. This would give, for the lower values of μ a smaller, and for the larger ones a larger boss than that taken in the other table, otherwise the comparison is exact with the line in it in which $\lambda=2$, λ being the value of $\frac{R\Omega}{K}$

$\frac{R\phi}{R\Omega}=\mu$	Horse Power.	Corresponding H.P. in other Table.
0·02	114	102·8
0·03	176	159·3
0·04	240	219·
0·05	305	281·6
0·06	372	347
0·07	441	415

The formula for the H.P. is in this case much more troublesome being

$$H.P.=Cv\frac{\phi^2\,\Omega^2}{(2\Omega+\phi)^2}\times\left(\frac{2\Omega(\Omega-\phi)}{\phi}+\tfrac{1}{2}\text{ hyp. log.}\frac{\Omega}{\phi}\right)$$

where C stands for the constant factor reducing to horse power, for a ten foot screw, at ten knots. The difference amounts to about 10% in the lower, and 6% in the higher values.

It will be observed that throughout this investigation the pitch of the propeller nowhere comes in directly. Indirectly it does, being fixed at any radius by the longitudinal and circumferential velocities of the water, and circumferential speed of the screw, and is easily ascertained graphically or otherwise when these are known.

The formation of a vortex of a type $r^2\omega=$constant might have been, and has been, previously surmised from the circumstance that it is that most easily produced in any liquid such as water. Any sink or suction hole is liable to produce a vortex, of this particular kind, and none other, on the smallest provocation, and the mixing of converging streams not originally forming a vortex in which $r^2\omega=$constant has a powerful propensity to get as near this form as they can, totally regardless of whether the vortex is in a vertical, horizontal, or inclined plane ; so that in taking such a vortex to be approximately that in a screw propeller, irrespective of the precise detail of form of blades, and other circumstances, no new, unknown, or strange doctrine is put forward, nor is the formation of such vortices even under much more discouraging circumstances in discordance with the facts of experience, but rather the contrary.

The Table of Horse Power, exhibited when the Paper to which this note is appended, was read, is subjoined.

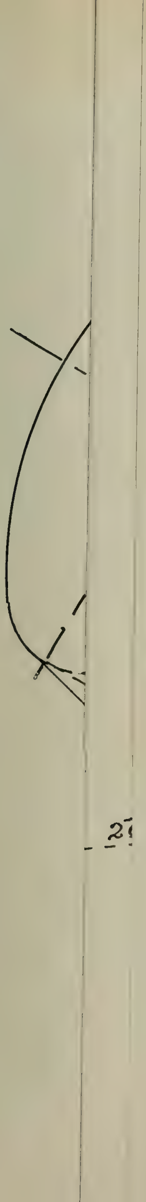


Fig. 1

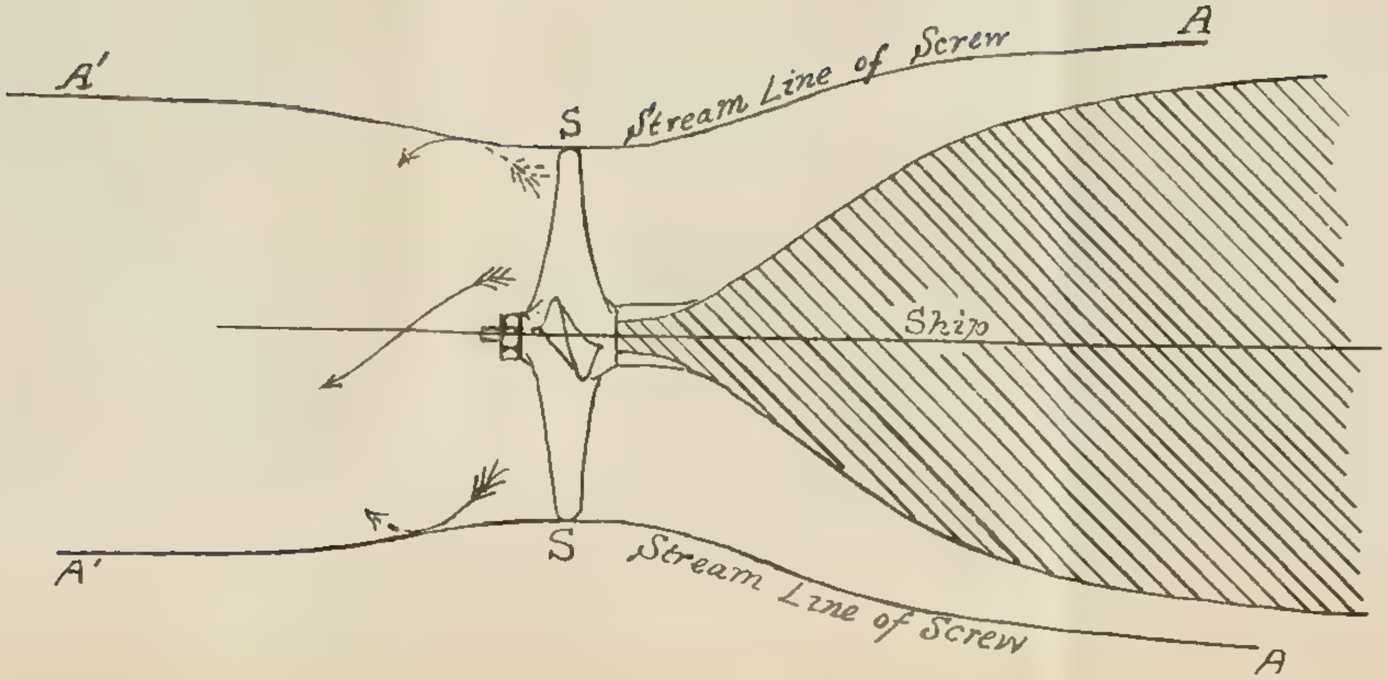


Fig 2

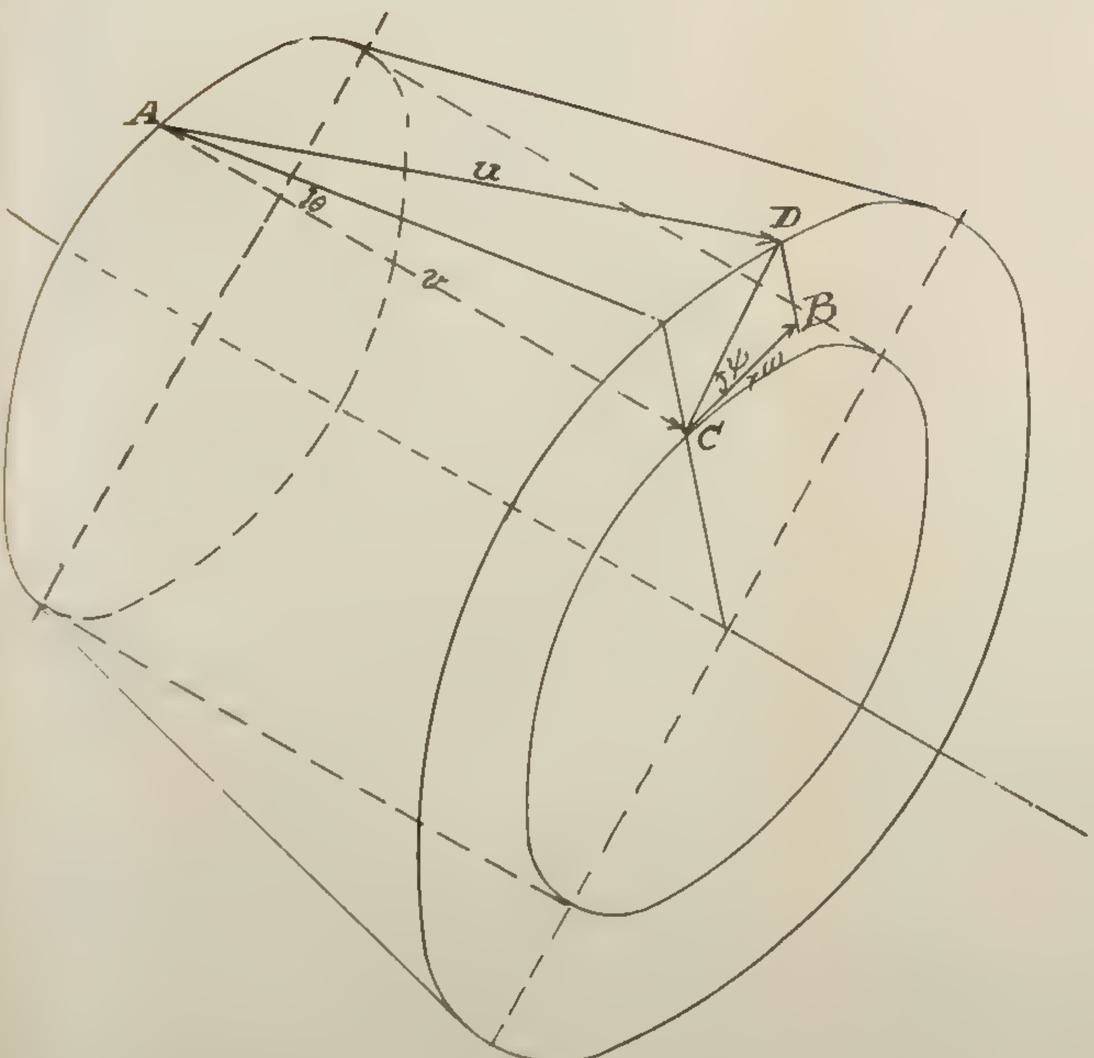
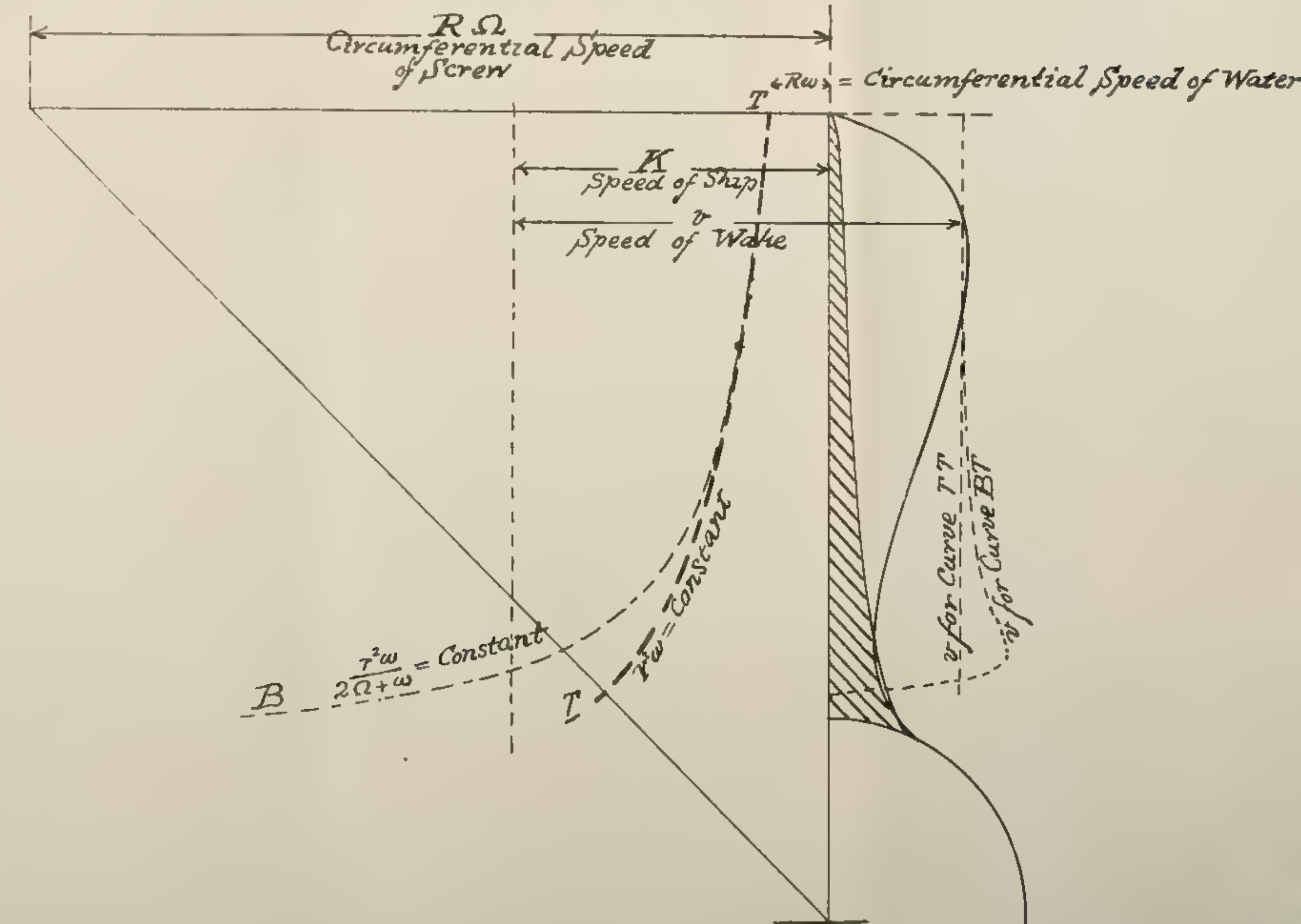


Fig 3



M. F. FitzGerald Inv^t & Del^t

Table of Horse Power of Screws 10 Feet Diameter at 10 Knots.

μ	0·003	0·006	0·01	0·015	0·02	0·025	0·03	0·04	0·05	0·06	0·07	0·08	
	3·6	7·2	12·1	18	24	30·5	37	49·5	62·5	76	89	103	H.P.
$\lambda=1·0$	1·003	1·006	1·01	1·015	1·02	1·025	1·03	1·04	1·05	1·06	1·07	1·08	$\frac{v}{K}$
	0·6	1·2	2	3	4	5	6	8	9·8	11·5	13·7	15·5	% Slip
	12	24	40	61	82·2	105	127	173	222	272	325	379	H.P
$\lambda=1·8$	1·009	1·02	1·03	1·045	1·06	1·075	1·09	1·12	1·15	1·17	1·20	1·22	$\frac{v}{K}$
	1·2	2·4	4	6	8	10·1	12·2	16	19·7	23·3	26·9	30·4	% Slip
	14·9	29·8	49·6	76·2	103	131	159	219	282	347	415	486	H.P.
$\lambda=2$	1·01	1·02	1·04	1·06	1·08	1·095	1·11	1·15	1·18	1·21	1·24	1·27	$\frac{v}{K}$
	1·4	2·9	4 9	7·8	9·6	12·1	14·6	19·2	23·8	28·3	32·7	37·2	% Slip
	17·6	35·7	60·6	93·4	126	161	197	272	350	434	...	...	H.P.
$\lambda=2·2$	1·01	1·03	1·05	1·07	1·09	1·11	1·13	1·17	1·21	1·25	...	...	$\frac{v}{K}$
	1·7	3·5	5·8	8·5	11·2	13·8	16·4	21	26	31	...	...	% Slip
	21	42·7	72·7	113	164	196	239	331	430	533	...	...	H.P.
$\lambda=2·4$	1·02	1·03	1·06	1·09	1·11	1·13	1·16	1·20	1·25	1·29	...	...	$\frac{v}{K}$
	2·0	4·0	6·8	9·9	13	16	19	25	31	37	...	...	% Slip
	24·7	49·6	86	134	182	234	286	399	520	647	...	...	H.P.
$\lambda=2·6$	1·02	1·04	1·07	1·10	1·13	1·15	1·18	1·24	1·29	1·34	...	...	$\frac{v}{K}$
	2·3	4·7	7·7	11·1	15	18·5	22	29	35	42	...	...	% Slip
	28·7	58·8	100·7	157	214	277	340	476	622	777	...	...	H.P.
$\lambda=2·8$	1·02	1·05	1·08	1·11	1·14	1·18	1·21	1·27	1·33	1·38	...	...	$\frac{v}{K}$
	2·6	5·2	8·9	12·9	16·8	20·4	24	32	39	47	...	..	% Slip
	33·1	67·9	117	189	250	325	399	562	736	923	...	...	H.P.
$\lambda=3·0$	1·03	1·05	1·08	1·12	1·16	1·20	1·24	1·31	1·37	1·43	...	...	$\frac{v}{K}$
	2·9	5·9	9·7	14·2	18·7	23	27	36	44	52	...	...	% Slip
	45	92·7	163	256	357	463	576	...	...	...	...	...	H.P.
$\lambda=3·5$	1·04	1·07	1·13	1·18	1·22	1·27	1·31	...	...	...	...	...	$\frac{v}{K}$
	3·9	7·7	13·6	19·7	24	29	35	...	...	...	...	...	% Slip
	59	127	220	349	488	639	803	...	...	...	...	...	H.P.
$\lambda=4·0$	1·05	1·09	1·15	1·22	1·28	1·34	1·39	..	..	...	...	...	$\frac{v}{K}$
	5·1	9·8	16·0	23·7	30	37	44	...	...	...	..	...	% Slip

For other Speeds and Diameters H.P.=(Tabular number) $\times D^2 V^3 \div 100{,}000$

Thrust in lbs.=2 (Flow in cubic feet per second) $\times (v-K)$

Slip is reckoned on Pitch at after Tip of Blade

APPENDIX III.

PROPOSED SUBMERGED BUOYANT BRIDGE BETWEEN IRELAND AND SCOTLAND FOR RAILWAY PURPOSES.

The President said that before calling on Mr. Maxton to read his paper, which formed the special business of the evening, he (the President) should like to point out that the amount of public attention recently drawn to the possibility of constructing a tunnel between Scotland and Ireland, made the subject of Mr. Maxton's paper one of absorbing interest. It would be totally impossible to estimate the advantage that would accrue to this country if railway communication could be established between Ireland and Scotland and England. Of course as a commercial speculation it could scarcely be called feasible, but he thought that the question was not altogether whether it would be a commercial success, but whether it would be of imperial interest to England and Ireland if a tunnel was made. With regard to the making of a tunnel between England and France, certain political questions arose which might be answered either in the affirmative or the negative. No such objection could be raised to the construction of a tunnel or some other means of Railway communication between Ireland and England or Scotland : but there was an imperial question which would have to be considered in connection with any such scheme proposed, either a "floating bridge" scheme, such as Mr. Maxton proposed, or any other. There was the possibility of this country being at war with some other country, when the tunnel or bridge might be destroyed by dynamite. This was a result which they might

expect, and the matter was one of the greatest importance to be taken into consideration when any scheme was mooted. He was perfectly certain if Mr. Maxton's proposals ever attained realisation it would be a source of intense gratification to the members of that society that the huge project first saw the light of day in the Belfast Museum. He should state that Mr. Maxton's paper had not arisen out of the recent discussion as to the feasibility of a tunnel between Ireland and Scotland. Mr. Maxton had mentioned the matter to him about two years ago, but it was only, however, within the last two or three months that he had put the matter in practical shape and worked up the details. The President then called upon Mr. Maxton, who proceeded to read his paper—

"A PROPOSED SUBMERGED BUOYANT BRIDGE."

As a preface to the subject matter proper of my paper I may remark that although the recent agitation as to the desirability of a more expeditious means of communication between Ireland and Great Britain did not prompt the idea of this proposal, yet it stimulated my efforts in working out the calculations, quantities and details of the proposed bridge, in order to bring before this Society at least one alternative scheme to the much talked of proposed tunnel under the North Channel.

The general idea of a submerged buoyant bridge originally occurred to me some six years ago as a practical substitute for a subaqueous tunnel, when there were such strong military objections raised against the scheme of Sir Edward Watkin's proposed English Channel Tunnel; objections which cannot be urged

against a bridge. Although neither political nor military objections against the North Channel Tunnel scheme are tenable, yet the engineering difficulties are stupendous, and much greater than those anticipated in the proposed English Channel Tunnel, whilst the anticipated traffic is considerably less.

In order to compare the "Submerged Bridge" scheme with the tunnel schemes, I have drawn sections of the North Channel (Fig. 2), shewing four of the principal proposed routes for a tunnel. How many more routes have been suggested it is difficult to ascertain ; they are numerous no doubt, and leading from as many points in Ireland to as many in Scotland, each, in the opinion of its advocate, presenting some special advantage.

Section *a* (Fig. 2) represents the contour of the channel bottom between Donaghadee and Portpatrick, a distance of 19 nautical miles. This route was preliminarily surveyed and favourably reported upon by an engineer now deceased.

Section *b* is that between the Great Copeland Island and Portpatrick, land to land $17\frac{1}{2}$ miles, plus $\frac{3}{4}$ mile of channel between the mainland and the island. Considerable advantages present themselves in this route, viz : the reduction of the distance between the working shafts by $1\frac{1}{2}$ miles, which would reduce the distance the *debris* would have to be conveyed during construction : additional working shafts could be constructed at the Irish end, thereby increasing the number of working faces, and shortening the distance between the nearest ventilating shafts ; all important considerations to engineers.

In these two Sections, *a* and *b*, there is a considerable depression nearer the Scotch than the Irish coast, at which the greatest depth is 890 feet ; this would involve exceptionally steep gradients, difficulties in pumping and ventilation, and an extraordinary expense and length of time :—matters quite beyond the object and scope of this paper.

Section *c* is that between Whitehead, or Blackhead and Portpatrick, a distance of 22 and 21 miles respectively. The shallowness of the channel in this route is its special recommendation, the greatest depth of water being 650 feet.

Section *d* is that between Tor Point and the Mull of Cantyre: this is the shortest water course ($11\frac{1}{4}$ miles) between Ireland and Scotland, and is the route suggested by Sir Edward Watkin's advisers. So far as regards the shortness of the tunnel this presents the most favourable route, but owing to the long and circuitous connections to be constructed at both ends, it does not appear that the advantage gained would be at all commensurate with the enormous expense entailed.

Section *e* shews the route of the proposed English Channel Tunnel, and is added here merely to illustrate the comparative depths of channels.

These sections which shew the relative depths of the Channels are drawn to scale: horizontally 1 inch equals 27,000 feet, and vertically 1 inch equals 600 feet.

The foregoing distances are the minimum subaqueous lengths of tunnels, to which must be added 4 to 5 miles to each route for subterraneous approach tunnels, even with the very heaviest workable gradients.

Subaqueous tunnelling is proverbially one of the most uncertain undertakings in civil engineering. Unforseen mishaps make even the most sanguine fear the results, and it is no uncommon occurrence in subaqueous tunnelling to have to abandon the work for a time, even in the most recent cases, such as the St. Clair and Severn.

The difficulties, doubts, and uncertainties seem to increase by geometrical progression as the lengths and depths, in subaqueous tunnelling.

The late Mr. Thomas A. Walker, who succeeded, after numerous attempts, in completing the Severn tunnel, said, "One such experience as the Severn tunnel, with its ever varying and strangely contorted strata and its dangers from floods above and floods below, is sufficient for me. One subaqueous tunnel is enough in a lifetime." These are the words of one of the largest and most successful railway, canal, bridge and tunnel contractors the world has ever seen, and who had contracts to the amount of £9,000,000 on hand when he died.

It is computed that the Severn tunnel cost almost £1,000,000 per mile of breadth of river to be tunnelled, and at the present time 1,000,000 gallons of water have to be pumped out per hour in order to keep the finished tunnel dry.

The St. Clair tunnel is another example of what one may expect in constructing subaqueous tunnels. It is only to be 2,300 yards long, with 770 yards subaqueous, for a single line; and, owing to the favourable material of the river-bed, the shallowness of the water, etc., the estimate was moderate, being £517,000, or about £75 per foot run; yet this modest estimate has already been exceeded, and the tunnel is still incomplete.

The Mersey tunnel, constructed under the most modern system, and under the most favourable conditions, cost about £76 per foot run.

Taking, then, these very favourable costs as data from which to approximately estimate the cost of the proposed North Channel tunnel, we have as the necessary sum £9,900,000, and, under favourable conditions, 16 to 20 years for its construction.

Again, assuming that the proposed tunnel would discharge the same quantity of water as the Severn, although the former would be nine times the subaqueous length of the latter, then it would require pumping engines developing 10,000 horse-power constantly working to keep the tunnel dry when complete. This would be one *small* item in the working expense. I have merely touched upon these points, lest the public should become too enthusiastic over a scheme founded principally upon assumptions that can never be verified until after the tunnel is complete.

It was after much deliberation that I decided upon the title for this paper, as the design of the proposed bridge contains some of the essentials of a bridge, of a viaduct, and of a tunnel (as will be readily understood by referring to their definitions), and the title, "Submerged Buoyant Bridge" is, perhaps, the most descriptive of the character and peculiarities of the structure. In order to compare it with existing bridges, I have procured a number of lantern slides illustrating different types of aërial

bridges from the most ancient to the great cantilever Forth bridge, recently opened, and I am enabled to show these on the screen, together with those having direct reference to the submerged bridge, through the very kind assistance of Mr. J. Brown, who has likewise generously lent the necessary apparatus.

[At this part of the proceedings a number of lime light views of aerial bridges, etc., were thrown on the screen, and their particular features explained; likewise sections and diagrams illustrating the proposed bridge, some of which are shown in figs. 1, 2, 3, 4, and 5 attached.]

The scheme which it is my wish to bring before your notice, and to submit for your criticism, is a proposed buoyant structure to carry a roadway through the water at any pre-arranged depth (which in this instance is 60 ft.) below the surface, held in position vertically and transversely by dead weight and other anchors attached to the bridge through steel or other metal wire rope cables placed at intervals.

The bridge is to lead from Donaghadee to Portpatrick.

The structure is to consist of a circular or elliptical outer shell of steel, *A* (see fig. 1, which represents a longitudinal and a transverse section), and an inner rectangular shell, *B*, both made water-tight and attached to each other through diaphragm plates, *C*, placed transversely about 24 in. apart, and riveted to the shells through double angles. These diaphragms are to be lightened by manholes punched out of them, except at intervals where they are to be solid, in order to make the cellular construction water-tight at certain intervals in its length.

The outer shell is to be coated with a layer of Portland cement, then bound with metal wire, tape, or netting, and these in turn covered with another layer of cement; the shell is to have projections so that the cement may adhere more firmly. Japan lacquer or bituminous cement could be substituted for the Portland cement, or the steel treated by Barff's, or other approved process, to afford a perfect protection to the steel against the corrosive action of sea water.

The bridge is to be constructed, on ways, in lengths of 400 ft. to 1,000 ft., tested by hydraulic pressure, and rolled or launched into the water, practically in a finished state.

The lengths are to be jointed by ordinary bolted flanges, and afterwards riveted from the inside, or the joints made on the expansion principle.

The space between the outer and inner shells is to be filled with water, and temporary water-tight bulkheads, *N* (*Fig.* 5), to be fitted a short distance back from each end. In this condition the lengths are to have a minimum reserve buoyancy consistent with safety. Each length is to be then towed out into the channel separately, as nearly over its final position as possible.

Here four or more temporary hydraulic hauling gears, previously placed, are to be attached to the length, so as to haul it down to its proper level; and it is in order to give these hydraulic apparatus as little work to do as possible that the reserve buoyancy of the lengths is proposed to be reduced to a minimum.

When the length under manipulation is to be hauled down nearly into a line with the shore end, or the part of the bridge assumed to be laid, another hydraulic gear is to be connected from the one to the other, and the length being laid is to be directed radially and centrally by conical and other guides fitted temporarily on the ends for that purpose, and so drawn hard against the fixed section. When the jointed faces come into exact relative position, several automatic catches are to lock the lengths together, and an india-rubber band, *O* (*Fig.* 5), is then to be strapped round the joint in order to make it water-tight for the time being.

Should access to the length of bridge under manipulation be required during laying operations, it may be obtained by divers through manholes at *M* (*Fig.* 5); but with the foregoing automatic arrangements this, under ordinary circumstances, would be quite unnecessary. It may be here stated that the hydraulic apparatus will all be under the control of one diver, who will go down with the length being laid and

will be stationed at the end near the joint. For facilities in manipulation, the cylinders of the hydraulic gears are to be made cellular, so that they may be in a state of indifferent equilibrium when in water.

The next operation will be to place the guy anchors, *E* and *F* (*Fig.* 4), and attach their cables *G* to the bridge to resist tidal currents. The anchor, *E*, is to be an ordinary one with fixed flukes; *F* to be made of concrete. These anchors may be either separate or self-contained ;—the ordinary one to resist the dragging tendency, and the concrete one to resist the resultant upward force. This combination is adopted with a view to reduce the length of the guy cables to within reasonable limits. When a pair of these anchors, with their cables attached, have been placed on each side of the bridge, the one pair directly opposite the other, the free ends of the cables are to be led on to a lighter and attached to hauling gear and strained in position to twice the working stress:—thus the two cables with their anchors will be tested at one operation. The upper ends of the cables are to be then rove through stuffing boxes near the outer end of the length of the bridge under manipulation, and attached to screws or barrels within the bridge, where they can be adjusted at any time, and be always accessible from the inside of the bridge after completion. The guy cables are to be coated with an impervious covering of substance lighter than water, in order to render them buoyant and so prevent any sag.

The vertical cables *H*, and concrete anchors *I* (*Figs.* 1 *and* 4), are then to be dealt with. Before the lengths leave the works on shore, these cables are to be cut to the exact lengths, and their upper ends rove through stuffing boxes *K* and secured to the adjusting nipper screws or barrels *L* (Fig. 2), which will be always accessible from the inside of the bridge. The cables are to be coiled and lashed to the length of the bridge for convenience.

A specially designed lighter must be used to carry four or six concrete anchors from the works on shore. When the cables are attached to their anchors, two of the latter are to be

lowered into position, one opposite the other. All the concrete anchors are to consist of pig-iron, basalt, and cement, or other heavy substance bound together by steel bars, rods and bands. All the wire cables are to be composed either of non-corrosive metal or alloy, or of steel served with bitumen and gutta-percha, and bound with brass tape, etc., in order to resist the corrosive action of the sea water. When all anchors and cables have been secured and manhole doors jointed, the bulkheads, N^1 and N^2 (*Fig.* 5), are to be removed from the inside, and the water in the space between N^1 and N^2 allowed to drain to the pump-well (*Fig.* 3). The process of screwing up the vertical and guy cables will then be proceeded with, and the water in the cellular compartments gradually allowed to drain to the pumps. The removal of the temporary rubber band *O*, and the making of the permanent joints, is to be left over until all the cables and anchors over several lengths have been under working strain for some time, to ensure that the joints shall not be overstrained owing to the lengths being out of line, or from other causes; then the bolting of flanges may be conducted from the inside, and the continuity of structure otherwise provided for.

The bridge is to be fitted at intervals of about 500 feet with pairs of water-tight doors *D* (*Fig.* 1), hinged from the roof and held open by a trigger catch, which will be released by the rising of a float, should water fill the passage to a depth of 3 feet, when the doors will close, and confine the flooding to a short section of the bridge. These doors are to be so designed as not to close when any part of the train is under them, and when closed, to exhibit a danger signal to warn any approaching trains.

The shore approaches to the bridge are to be constructed in the form of a breakwater, built round a tube, as clearly shown in *Fig.* 3; the buoyant bridge is to start from point *Q*, at the bottom of the gradient, which will be about 1 in 60; from this point to the middle length of the bridge there is to be a spring of 1 in 600 for drainage purposes, and a drainage heading made leading to a pump well shown on the sketch. Under normal conditions there

will be no leakage into the bridge; so that the pumps may be of the centrifugal type, and will be required only in case of accident or repairs to the structure.

The motive power for trains is to be electricity, or compressed air heated when being used; the heat is to be stored in a mixture of water and glycerine, in order to dispense with the elaborate and enormously expensive ventilating appliances necessary for a tunnel of such a length, if ordinary locomotives were used. If necessary, ventilating shafts may be provided at intervals to come above water level in the channel, having the necessary lights, etc., fitted to warn vessels when in their vicinity.

The front and rear carriages of the train are to be fitted with shutter-doors, actuated either automatically or by the persons in charge of the train. These shutters will practically close the space between the carriages and the inner shell of the bridge, and in case of flooding convert the train into a piston, in order that the trains may be driven out in safety by the inrush of water.

The ventilation will be induced by the motion of the trains themselves. If, however, that is not sufficient, the idle pumping engines at the shore ends may be utilized.

The foregoing is a general outline of the proposed bridge, and a few of the more important features may now be touched upon which may commend themselves to engineers, promoters, or probable proprietors and the travelling public.

Should the outer shell get pierced, this would have the effect of flooding a short length of the cellular space round the inner shell only, and would in no way interfere with ordinary traffic through the bridge. Should both shells be pierced, the outer space for a short distance would be flooded, and the inner shell between the automatic flood-gates, *D* (*Fig.* 1), only. Should, by any conceivable means, the whole of the passage-way get flooded, the design is such that the bridge would still float. Should a train be in the bridge when any inrush of water takes place, the expanding shutters at the front or rear of the train would prevent the water from passing, and, instead, the water would drive the train out, as a carrier is driven through a pneumatic tube.

It may be remarked that the stresses on the bridge will be reduced in the immediate vicinity of the train.

[Models of short lengths of the proposed bridge were exhibited and experiments conducted, demonstrating its strength, buoyancy, righting moment, resistance to oscillations, steadiness of platform, and the efficiency of all the above mentioned safeguards provided in the bridge against dangers of flooding under all possible conditions. The last mentioned safeguard was demonstrated by means of a model bridge, 9 ft. long, attached to a water tank; a model of a train was then put into the bridge, and by opening a valve the water rushed into the bridge and shot the train out at the opposite end.]

The factors of safety in the structure of the bridge throughout are high, the lowest being 7.

The estimated cost at current prices, including depreciation of plant and Parliamentary and preliminary expenses, is $5\frac{1}{4}$ million pounds, and the time for completion from date of commencement $5\frac{1}{2}$ years.

Comparing these with the cost and time required to construct a tunnel under the channel, the advantages of a bridge such as the proposed stand out strongly, and would make the relative cost of the bridge compared with the tunnel as about 1 to 5.

The facilities for constructing the bridge are extraordinary compared with a tunnel, or in fact with any other bridge yet made. A gentleman of vast experience in similar structures states that he would undertake to construct the structural part of the bridge in $2\frac{1}{2}$ years with special plant and 1,500 men. The making of the approaches and concrete anchors, and the laying of the sections, may all be advancing at the same time, and the distribution of men may be most advantageously made to ensure expedition.

Although the foregoing paper was prepared in order to illustrate the feasibility of bridging the North Channel, the proposed submerged bridge is applicable for carrying roads across other channels, straits, gulfs, estuaries, rivers, lakes, etc.,

completely dispensing with all uncertain tunnelling and substructures. The parts could be made and practically finished at any distance from the site, which is of immense importance to engineers and contractors.

In channels, etc., where depth and bottom will permit, the design of bridge would undergo considerable modifications in form, etc. It would not then be buoyant, but could rest on the bottom and be made of the best form to resist erosion and currents; the levelling of the bed could be done by hydraulic excavation or by dredging, or the bridge could rest upon and be bolted to submerged piers, thereby dispensing with anchors and cables; the buoyancy being resisted by any suitable means, such as filling in the space between the shells by concrete, etc.

I have to thank Mr. George Kyle, B.A., C.E., for checking over some of my calculations, who likewise, together with Mr. James Turpin, jun., helped me to prepare plans and work out quantities for this paper.

The President, in opening the discussion on the paper, said that a good many might hesitate to spend five millions to have such a scheme as Mr. Maxton proposed carried out, but it would be of immense importance that some tunnel or some other means could be constructed for the purpose of conveying letters and parcels from this country to Great Britain, and *vice versa*. In this way the practicability of carrying out Mr. Maxton's scheme could be tested.

Professor Fitzgerald, after making some observations as to the torsional stresses that would come on the structure under assumed conditions (not explained) for which he had made calculations, said that Mr. Maxton had omitted to mention the provisions arranged for to guard against the stresses likely to be set up by vibrations, but said they could very easily be met. Having criticised a number of other details, he said that Mr

Maxton had ingeniously surmounted a great many of the difficulties in the way of constructing such a tunnel or floating bridge as he proposed. He believed if ever any tunnel were made under the North Channel, it would have to be something like this "floating" plan. He did not believe in the possibility of boring a tunnel under the North Channel, as the conditions as to the character of the rock strata, depth, etc., were totally different from those of the English Channel.

After some observations from Messrs. Robert Young and William Armstrong,

Mr. J. Brown wished to know how Mr. Maxton would prevent galvanic corrosion, as salt water was particularly destructive to iron. Referring to the ventilation of the tunnel by the trains themselves, he thought this would not clear the tunnel completely, as trains passing alternately in opposite directions might leave a portion of the foul air in the centre that would not be expelled.

Mr. John Workman made some suggestions as to having the "staying anchors" fastened to the bridge by rings. With regard to the ventilation, he knew that the ventilation in the Mont Cenis and Mont St. Gothard tunnels was especially good, so much so that they could leave the windows of the carriages open. He supposed there was some arrangement by which the air was brought into the centre.

The President thought that in view of the remote contingency of the tunnel being pierced, some arrangements should be made which would prevent the water smashing the carriages by floating them so as to strike the roof. There might be a special construction of carriages, and a guide rail on the top to prevent such a contingency as he had mentioned.

Mr. Maxton, in replying, said he thought on the whole the criticism had been rather favourable to his scheme than otherwise. Professor Fitzgerald had pointed out some difficulties, and, better still, had pointed out the remedies. The points raised as to the rolling and vibration of the bridge could be quite easily met, and also as to the ventilation; the latter

would be still further simplified if there were two separate bridges for a double track. He calculated upon the train being drawn through the tunnel by electricity, in the same manner as in the case of the London Subway, or by compressed air. Smokeless locomotives were in use in other tunnels; in this way tunnels were infinitely more easily kept ventilated. With regard to corrosion, it was a question which always presented many difficulties to marine engineers. However, if the steel of the bridge were perfectly covered in the way he had described with Portland cement, there would be no danger of its corroding. He knew instances where iron that had been coated with this cement was as good to-day as it was twenty years ago. Then as to deep anchorages; as the anchorage was particularly good inshore he expected that it would be the same in deep water, as the bottom right across was similar He had been so informed by authorities. In conclusion, he thanked the audience for having so attentively listened to him, and the gentlemen who had offered criticisms on his paper.

Had he been reading the paper before a body of experts pure and simple he would have gone minutely into the more scientific problems involved in such a structure; but having been requested to prepare the paper in a popular form he had endeavoured to omit the too technical subjects referred to by some of the speakers.

Since this paper was read I observe that Sir E. J. Reed, M.P., has lodged a Provisional Specification of a patent for submerged bridges to connect railways, and in a recent issue of the *Contract Journal*, it is stated that a well known scientific M.P. is now busily engaged designing a Submerged Bridge for railway connection between England and France, at the instigation of Sir Edward Watkin, M.P.—J. M.

Fig. 1.

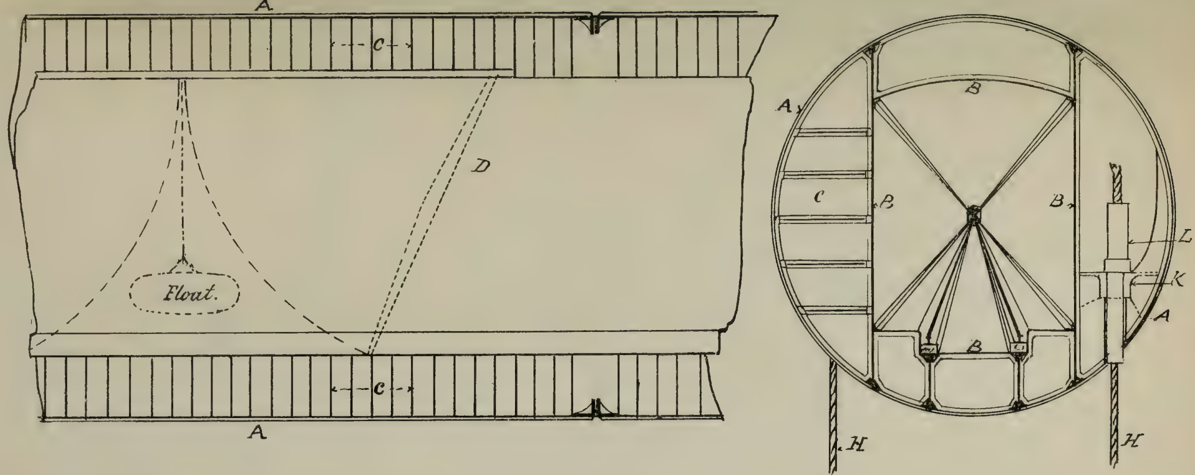


Fig. 5.

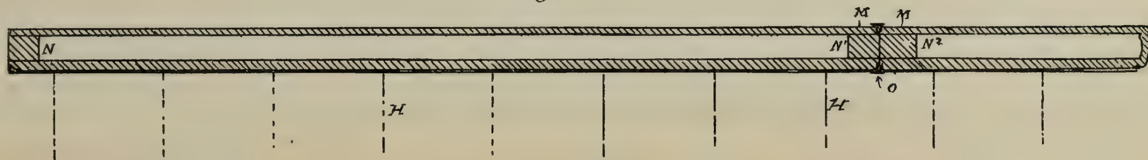


Fig. 2.

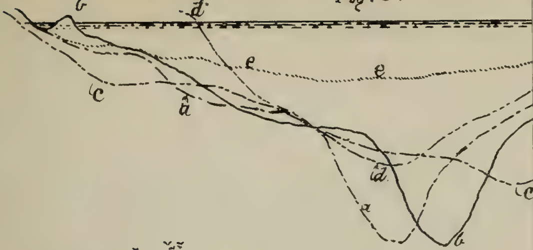
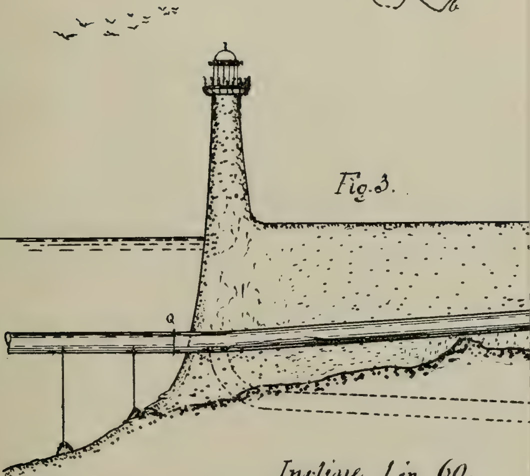


Fig. 3.



Incline 1 in 60.

Fig. 4.

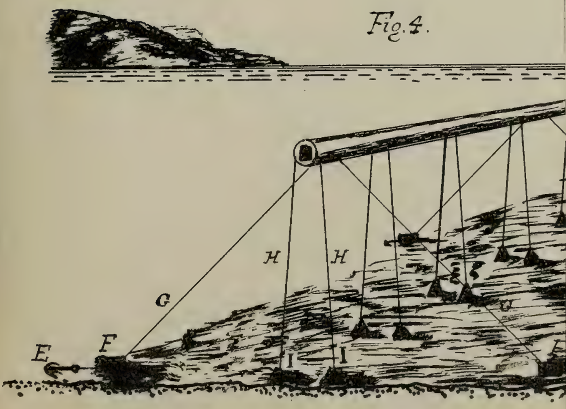
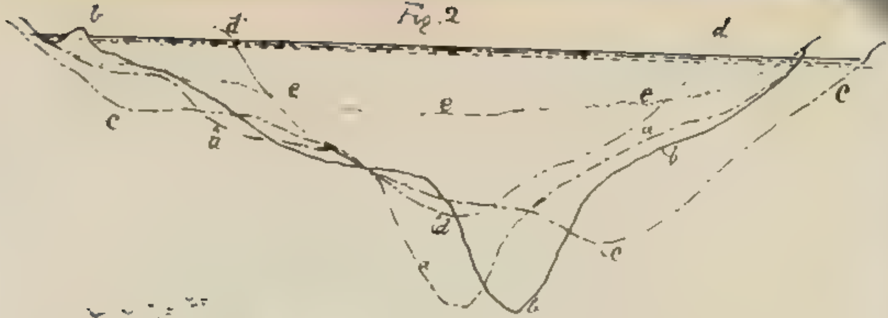


Fig. 2



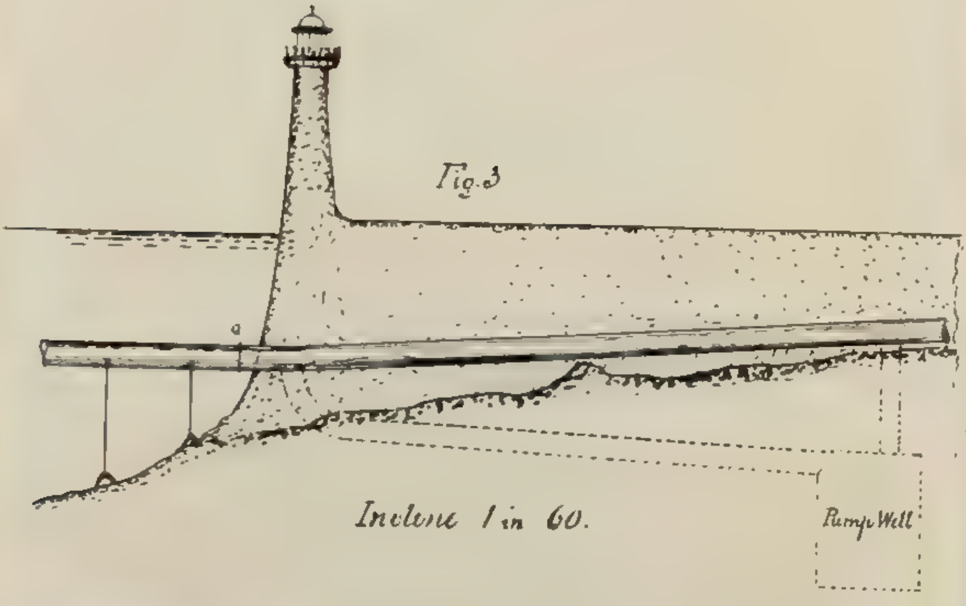
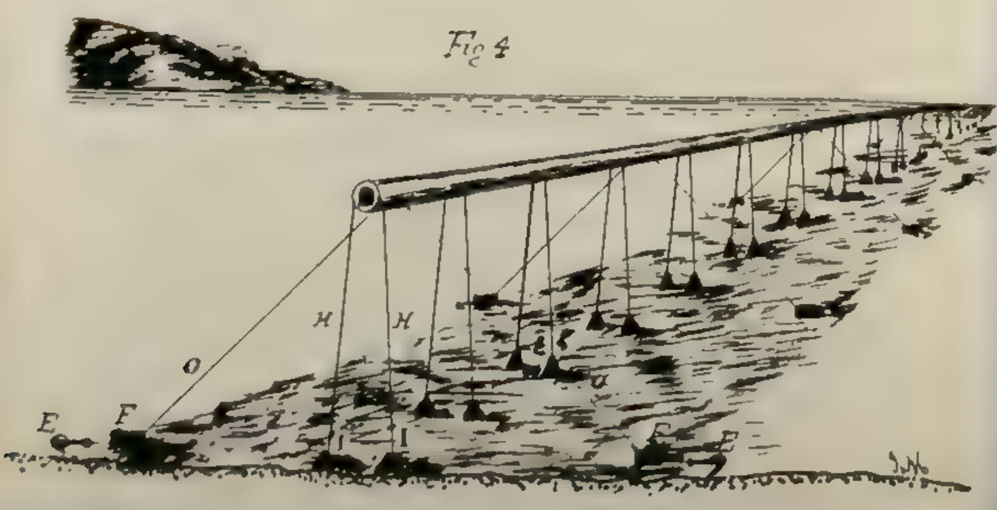


Fig. 3

Incline 1 in 60.

Fig 4



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